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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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SESSION 1916-17.

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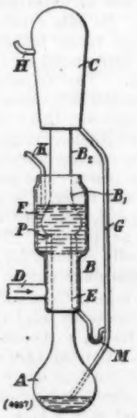
HIGH VACUUM MERCURY VAPOUR PUMP.

LAST year Dr. W. Gaede, to whom scientists owe the molecular pump, added one more to his list of new remarkable air pumps. This pump worked on the well-understood jet or aspirator principle and on the diffusion principle, which had not so far been utilised in air pumps. When a jet of steam, *e.g.*, is ejected at high velocity, a partial vacuum is produced, and the gas particles surrounding the jet are drawn into it. This action must cease when a certain degree of exhaustion is reached; for if the jet were surrounded by a vacuum, the gas molecules of the blast would be driven into the vacuum. Hence some device was wanted which prevented gas escaping from the jet to pass back into the vessel to be exhausted, and which further induced air at low pressure to enter the jet. In his diffusion pump Gaede made use of a blast of mercury vapour and of a porous diaphragm, or—what theoretically came to the same thing—of a slot so narrow that its width was comparable to the mean free path of the mercury atoms in the blast. A portion of the mercury blast escapes through the slot, and the gas to be exhausted diffuses in against this blast of mercury. But the slot had to be very narrow (0.1 mm.), and the working speed of the pump was hence low, being about 80 cub. cm. per second at a pressure of 0.001 mm. when a molecular pump would deal with 1200 cub. cm. per second. In a



long contribution to the Annalen der Physik, volume 46, pages 357–392, Gaede went fully into the theory of this pump, and showed the fallacy of the common belief that a mercury-vapour pump could not produce any exhaustion below the vapour tension of the mercury in the pump.

In order to improve the rate of working, the slot had to be widened, and Dr. Irving Langmuir devised several arrangements, one of which is illustrated in the diagram annexed. Mercury is heated in the flask A and escapes through the neck into the tube B, which widens out higher up, into the bulb B_1, narrows again to the tube B_2, and enters the condenser C. The tube B is, in its lower portion, surrounded by an annular space E, from which the connection D branches off over to the vessel to be exhausted. The bulb B_2 is surrounded by the jacket F, which is filled with cold water up to an adjustable level. From the bottom of the condenser C a tube, G, extends down to the flask, and this tube is joined by a branch reaching over to E; any mercury condensing in C and E would flow back to A through the tube G. At H the condenser is further connected to the "rough" pump. The pump is said to work in the following way. The mercury atoms escaping from A into B radiate out in all directions; some enter the condenser C directly, others strike the walls of B and are condensed on B_2. When there is no water in F, this mercury will almost immediately re-evaporate, and new mercury atoms coming up B will collide with the re-evaporated atoms and will be deflected downward and condense into E; air from the vessel to be exhausted cannot enter through D, therefore, because the mercury blast is downward in E. When cold water circulates through F, however, all the mercury striking the walls B_1 is condensed on them, and there is no rush of mercury vapour down E. The air from D thus passes freely up through E, and when it meets the mercury-vapour blast in the plane P, it is blown outward and upward along the walls of B_1 and finally poured into the main stream of mercury vapours passing through B_2 into the condenser C.

In the Physical Review of last month Dr. Langmuir gives some particulars as to the working of his pump, when D was coupled with an air vessel of 11 litres capacity. The pressure observed after 0, 30, 60, 80 seconds, was in the vessel to be exhausted, 1,470, 294, 12.8, 0.015 bars, and in the condenser C, 1,160, 720, 218, 18 bars. The rough pump had a speed of 200 cub. cm. per second at 400 bars, and this speed fell off to 60 cub. cm. at 40 bars, and became 0 at 10 bars. The speed of the mercury pump on the other hand increased rapidly as the pressure decreased, and reached its apparent maximum of 4,000 cub. cm. per second at 10 bars; theoretically this maximum should remain constant on further reducing the pressure. With hydrogen the maximum was about 7,000 cub. cm. per second. This constancy is the advantage of the diffusion pumps, whilst in most pumps the rate of exhaustion falls off rapidly as the pressure is reduced to really low values of the order of 0.001 mm. Langmuir has already been able in the Research Laboratory of the General Electric Company, at Schenectady, further to simplify the pump which, as sketched, was made of glass; the other pumps are made of metal, but some time will probably elapse before particulars are published.

ORE CONCENTRATION BY FLOTATION.

FLOTATION of mines and flotation of ores have nothing to do with one another, and yet have some features in common. Large capitals have been sunk and lost in both the flotations, and it is not always the good stuff that floats. Mine flotation is an old art, ore flotation not older than this century—though patents go further back—but it is a rapidly developing art. Ordinary ore concentration relies on gravity and has its limits. There comes a stage when further agitation and settling do not lead to further separation of ore and gangue, or of precious and base ore, and when magnetic and electrostatic concentration fail in their restricted utility. Chemical and metallurgical treatment, lixiviation, roasting, &c., generally follow these separations, though they may be introduced at an earlier stage. In any case, thousands of tons of tailings accumulate daily on dump heaps as unfit for metallurgical smelting although known to contain enough good ore probably—if only it could be isolated—to turn a moribund concern into a prosperous undertaking. It is mostly sulphide tailings that are submitted to flotation.

Everybody knows the trick of making a steel needle float. In ore flotation, surface tension, gas adhesion, and coagulation of colloids are supposed to do the trick—how, is imperfectly understood. The ore pulp is agitated and mixed with acid, soap and oil, which adhere more to the ores—at any rate, to sulphides, to which operations are so far practically confined—than to the gangue and make the gas bubbles (air or carbon dioxide liberated, the weak acid does not attack the sulphides) adhere likewise, so that the sulphide rises and floats whilst the gangue sinks. This operation may be effected in a great many ways, and the mechanical and hydraulic devices used probably have more to do with the success of a process than the claims of the many patents. Of these about 200 have, we believe, been taken out in this country and the United States alone. William Haynes started the list in England in 1860, by mixing the pulp with oily or gummy matter. Twenty-five years later an experimental plant was actually put up in Oregon, on the strength of the remarkable "strictly feminine" invention of a Miss C. Everson, who finally—about three years ago—turned out to have been Mrs. Everson, wife of an assayist of that name, who was the real inventor, but who preferred to take out patents in his wife's name. After 1900, patents simply floated up, especially in Australia and America, and with success came a lively crop of law-suits. In deciding one of these cases between British litigants, in 1909, the Lord Chancellor remarked that the patent seemed to have been drawn up with great subtlety in order that the claims might be expanded or contracted as occasion required; this remark would apply equally well to other patents. But the litigation had the one good result that it led to compromising and combining, without, on the other hand, doing away with secrecy. We may describe a few of the processes actually in use and then refer to the theory and general features.*

Flotation Processes.—The Potter-Delprat process adopted by the Broken Hill Proprietary Company was the first worked on a large scale and marked the initiation of the Broken Hill zinc† industry. Mr. Charles V. Potter proposed, in 1902, to mix the tailings from the lead concentrating mill with sulphuric acid, Mr. Guillaume D. Delprat (general manager of the Proprietary Company) used the acid sodium sulphate from the salt cake of the Leblanc soda process. The two processes were at first rivals. The tailings are re-crushed and delivered into tapering flotation vats (wood, lined with lead), the pulp sliding down the walls of the vat to the bottom, which has a blind pocket and an open pocket; a low partition lies between the two pockets. Pipes introduce acid of 2 or 3 per cent. strength at 80 deg. C.—the hottest acid used in any of these processes—into the vat end just above the pockets. The tailings pass over the partition, which keeps back big lumps, and are stirred up by the acid, which liberates carbonic acid from the carbonate in the ores, and makes the sulphide rise to be discharged over the lip of the vat, whilst the gangue falls out through the open pocket. Steam is introduced into the vat at 260 deg. C. The inventors did not use oil when describing their plant in 1906, but the action of the acid on some organic (gummy) compound in the ores made the solution froth; later on oils were actually added by the Zinc Corporation. The gum had the disadvantage that it prevented subsequent treatment on tables. Mechanically the process is very simple, and the vats, of 6 ft. depth, capable of dealing with up to 12 tons of pulp per hour, form a cheap flotation plant; only one flotation is needed.

A. J. de Bavay in his process first relied on surface tension only, but later he adopted both acid and oil for his solution. A characteristic part of the plant was the agitator provided with a central tube, raised or lowered by rack and pinion, for stirring up the pulp several times with solution; the solution contained 2 lb. of kerosene and some chlorine gas per ton of ore. Later, several vats were used in series, the pulp being fed over conical distributors into conical vats, both these parts securing ample aeration of the pulp. An excellent concentrate was obtained, partly, it is thought, owing to the previous removal of slimes.

The Minerals Separation process rested originally on the patents of A. J. Cattermole (1902), who emulsified the ore with a little oil and soap, and of H. L. Sulman, H. F. K. Picard, Ballot, Higgins and others; the company subsequently acquired the patents of De Bavay and others. The pulp, oil—only 0.1 per cent. of the sulphide weight—and acid are fed into mixers or frothers, from which they pass into a spitzkasten; the discharged gangue is, at lower levels, treated once or twice more in the same way, or six frothers are arranged in series on the same level and combined with three spitzkastens. The working temperature is 60 or 70 deg. C. One of the chief parts of the plant is the single-lever agitator or valveless apparatus of T. J. Hoover. In each mixer a disc or wheel, attached to a vertical belt-driven shaft, is turned at 1,200 or 1,400 r.p.m., so that the liquid is thrown against the walls of the

* There is little collective literature on the subject. Recent books are: "Concentrating Ores by Flotation," by Theodore J. Hoover, 3rd edition (London, 1916); and "The Flotation Process," by T. A. Rickard (San Francisco, 1916). We may mention also two recent papers: "Notes on Flotation," by J. M. Callow (his process and theory); Bulletin, American Institute of Mining Engineers, December, 1915); "The Flotation of Minerals," by Robert J. Anderson (theory only, *ibid.*, July, 1916).

† The famous silver mines of Broken Hill practically gave out years ago. The average assay of the floated tailings dealt with by the Zinc Flotation Plant of the Broken Hill Proprietary Company in 1915 yielded: Zinc, 46.17 per cent.; lead, 6.56 per cent.; silver, 13.07 oz., to the ton. These figures are exceptionally high; the zinc percentage has frequently been down to 12.

mixer; the mixers communicate by ports with one another and discharge their froth over inclined lips into the spitzkasten; one or more of the frothers may act as pump, securing the series-flow through the apparatus. The presence of some slime is an advantage, as it secures a good froth; some soluble oil is wanted, and for this purpose alcohol, turpentine or essential oil of eucalyptus amygdalena is used; this oil need not be burnt out afterwards before treating the concentrate on tables. The Zinc Corporation, which adopted the minerals process (for the second time) in 1911, after trials of several processes, deals particularly with slimes, about which we shall have to say a little more presently.

The vacuum process of Francis E. Elmore (1904) differs from others in its principle; it has been tried in many countries, such as Wales, Sweden, Norway, Africa, and is in use, *e.g.*, in the Telemarken and Sulitelma Mines, Scandinavia, for the concentration of chalcopyrite and bornite (copper ores), occurring with iron pyrite and mica-schists. Elmore had originally patented the use of pumps when using a good deal of oil and acid. In his vacuum machine the pulp, with little oil and acid, passes through a horizontal trough, in which it is agitated and aerated by beaters attached to the horizontal shaft, into a funnel, and is sucked up a tube up to 30 ft. high, into the conical vacuum vessel, over the wide bottom of which a scraper sweeps. The reduced air pressure releases the air in fine bubbles, which carry the ore upwards to the narrow top and over the side of the vacuum chamber into a pipe which descends vertically, say 35 ft., the tailings being discharged from the cone bottom through another pipe; the pipes form a system of siphons. The capacity of a chamber of 5 ft. diameter is about 40 tons per day, and from 3 to 10 lb. of oil are required per ton of ore. Electrolysis and heating may assist the gas evolution generally. Elmore, like others, works generally, however, with cold water.

Another method is carried out by means of the rotating tube of A. P. S. Macquisten, which is also peculiar. A cylinder, 1 ft. diameter, 6 ft. long, is cast in iron, with two tyres on the outside (to rest on rollers), and a helical groove of 1½-in. pitch inside; the tube is rotated at 30 r.p.m. The pulp enters at one end, and is "screwed" through the tube, the gangue sliding back into the solution, whilst the sulphide floats and is discharged into a separating box, from the bottom of which the tailings escape. The treatment is repeated, so that the capacity of several tubes is only about 5 tons of ore per day. This tube is used in Idaho; slimes cannot be dealt with.

The process of James M. Hyde is worked by the Butte and Superior Company, Montana, who adopted it in 1912. The crushed material (blende, quartz, granite, &c.), is first mixed in the "thickener" with acid and some copperas, alum, &c., to hasten the coagulation and settlement of slimes. The pulp is then pumped through a series of three agitators and tanks (somewhat like those of the Minerals Separation process), in which it is mixed with oil, and the floating concentrate is once more sent through similar apparatus.

Having experimented with the Macquisten tube and other apparatus, Mr. J. M. Callow introduced his own process in 1913, at the National Copper Company, at Mulan, Idaho, and the process is now worked in a large number of copper, lead, and zinc mines, his plants having a total capacity of 25,000 tons per day. The chief parts are the "rougher and cleaner" cells. The treatment—of ores containing, *e.g.*, 10 per cent. of zinc and 5 per cent. of lead, and 10 oz. of silver—sometimes begins in a Pachuca mixer, a tank with a conical bottom, into which the pulp, oil and compressed air are fed; when the oil can be fed into the crusher or tube mill, the mixer is not required. A rougher cell (wood) has a length of 9 ft. by 2 ft. width and a sloping bottom, the liquid depth increasing from 20 in. at the entrance to 45 in. at the discharge. The important feature is the porous bottom, consisting of four layers of loose canvas twill, backed by perforated metal; underneath this bottom are eight small compartments, each joined by a pipe with a valve to a blower delivering air at 5 lb. per square inch; the valves adapt the pressure in the different compartments to the different heights of liquid above them; a square foot of porous medium admits about 8 cub. ft. of air per minute. The froth is discharged over the longitudinal edges of the well; the tailings pass into the cleaner cell, which is just like a rougher, but worked at a lower air pressure; roughers and cleaners can be combined in series and in parallel, there being as a rule only a few cleaners or none. The capacity of a rougher may rise to 50 tons per day. The froth layer has a thickness of about 15 in. Up to 5 parts of water to 1 of ore are required. The oils used (1 or 2 lb. per ton of ore) are distinguished as frothers and collectors; pine oils are good frothers, coal-tar products good collectors. At the Inspiration Mill the mixture is 80 per cent. of crude coal tar, 20 of creosote; at Daly Judge the mixture is 40 per cent. each of crude tar and creosote, 20 of pine oil. Pine oil gives small bubbles (¼ or ½ in.), creosote bubbles of 3 or 4 in.; the bubbles all collapse quickly; oils miscible with water are preferred; highly volatile oils are only serviceable as solvents for other oils. The cost of working a large plant (2,000 tons daily) is estimated at 6.75 cents (a little more than 3*d*.) per ton (1.25 cents labour, 2.50 oil, 2.50 power); it is difficult to say what this exceedingly low figure comprises. Two men may work 60 cells, and the power may be 1 or 2 kw.-hours per ton of ore.

Slimes and Selective Flotation.—The slime difficulty has proved very great in many plants. The Minerals Separation process has been successful with slimes from the first; the coagulation of slimes by the Hyde process also looks commendable, and E. J. Horwood has managed to make slimes amenable to the Potter-Delprat process. With a lively generation of carbon dioxide or of big air bubbles slimes are not carried up; they require small bubbles, and Horwood introduced centrifugal pumps between successive separating boxes to break up the bubbles. Horwood has also been successful with what is called selective flotation by some, and preferential or differential flotation by others. The terms concern the separation by flotation of one sulphide from another, in which field little has so far been achieved. Mixed sulphides of iron, copper, lead, zinc, Horwood roasts, in Broken Hill and Tasmania, in an Edward furnace below 400 deg. C., so as to oxidise all the sulphides except blende, and then submits the ore to hot acid-oil flotation; the roasting may be intermittent. Kenneth A. Mickle treats the mixed sulphides to be oxidised with ferric chloride. James Lyster works on another principle; he floats the galena alone by means of eucalyptus oil and some alkaline or neutral (not acid) solution of sulphates, nitrates, chlorides of the alkalis and alkaline earths; the Broken Hill water, which is rather salt, proved serviceable for this treatment, which requires a centrifugal apparatus. It almost looks, however, as if the copper lining of the apparatus were not unimportant in the process; an electrolytic effect (a slight copper plating of the galena) is suggested by Hoover.

Of other proposals for flotation we may mention the greased belts of Haultain and Stovel (reminding us of the greased tables for catching the diamonds at Kimberley), the differential emulsifier of T. M. Owen (eucalyptus oil and cold water), Henry E. Wood's separation by a swift current of water, and the sulpho-chlorinated oil of J. D. Wood.

Theory.—Much has been written and experimented on the theory of flotation, and the phenomena can apparently be traced down to surface tension, modified by oil and acid films, and to electric charges of the small particles and gas bubbles. But the details of the complex phenomena, and especially the part played by soluble oils (or tars), are not clear. The surface tension of water is high and is decreased by the addition to the water of most other substances, *e.g.*, of acids and oils. In other words, the interfacial tension between water and air is decreased by these additions, and that involves adsorption in the one or the other sense. When the contaminant reduces the surface tension of the water, the concentration of the contaminant (oil) tends to increase in the surface layer, and decrease hence in the liquid (positive adsorption); in the opposite case the contaminant is drawn from the surface into the liquid itself (negative adsorption). In the flotation pulp we have all kinds of phases and interphases: ore-water, water-oil, oil-air, &c., and various adsorptions. Whether a substance is wetted by a liquid or not depends upon these interfacial tensions. Quartz and most gangue minerals are wetted by water, sulphides are not; but the sulphides are wetted by oil and have also a strong adhesive power for gas bubbles. Oil replaces water at the surface of sulphides; water replaces oil at the surface of gangue minerals, and replaces gas more readily at an oiled solid surface than at a clean surface. When a mixture of sulphide and gangue is introduced at the surface of oil floating on water, the sulphide particles tend to migrate into the surface layer, while the gangue particles travel into the water. Thus the sulphides float, when on the surface, and rise from the agitated pulp.

When the particles are very small, colloidal and electric properties come into play. All small particles, solid or liquid, suspended in water carry electric charges; particles of the same charges repel one another, particles of opposite charges attract one another and coalesce. Gangue particles, oil drops and air bubbles generally carry negative charges, sulphides positive charges. Now negative colloids like tannin and saponin will not float, positive colloids like Congo red will float and favour flotation. Hence the experimenters of the Bureau of Mines, R. C. Bacon and, J. A. Block, and further, O. C. Ralston and Callow, advocate an electrostatic theory of flotation. In support of this view Block describes an experiment on electrolytic clay purification. He fills a trough with the clay pulp; in the pulp turns, half-immersed in it, a cylinder of iron, surrounded at a distance of ½ in. by a wire screen. The cylinder and screen are charged to a potential difference of 50 volts. The clay particles (negative) then travel towards the positively charged cylinder, the positively electrified pyrite, &c., to the negatively charged screen. This is hardly a case in point. The potential differences of colloids are of the order of a small fraction of a volt, and they depend, moreover, on the presence of electrolysis even as to sign. The electric forces help, but they hardly account for flotation, and the electrostatic parallel must not be pressed too far.

General Consideration, Cyanidation.—So far flotation has been restricted to sulphides and the similar tellurides, &c. Oxides, carbonates, &c., have not been floated yet. Careful testing of the various methods available must in every case precede the laying down of a plant. In any case the percentage profits are low, and only a large plant is likely to prosper. In the Joplin district of Colorado flotation has been successful in one mine only. The addition of acid to eucalyptus oil has proved useless in Burraya. The presence of more than 5 per cent. of minerals which would liberate carbon dioxide is not desirable; the acid would be wasted and a lively gas generation in large bubbles does not favour flotation. Fluorspar has been found to float together with blende in Mexico. In Scandinavian ores iron pyrite is too plentiful sometimes to make flotation successful. The separation of graphite by flotation fails because the grain of the graphite is destroyed by the fine crushing, which would yield a graphite suitable as lubricant only; any trace of quartz would, however, spoil such a graphite.

The general disadvantages of flotation are that the resulting concentrates are very fine and dusty, and that flotation does not always fit into the combination of metallurgical processes. We have already referred to subsequent table treatment. The gold and silver in ores have to be recovered, very often by cyanidation. The Mount Morgan siliceous copper ores are now being floated by the Minerals Separation process; but there is no cyanidation there. Where cyanidation follows, the oil is burned out of the floated concentrates; but roasting of the oily concentrates is troublesome. Traces of oil and also of acid would be most objectionable in the cyanide baths; the oil would render the cyanide ineffective, and the acid liberate hydrocyanic acid. Amalgamation after flotation also seems to be out of the question. These difficulties have been much discussed of late. On the other hand, the advantages of flotation are obvious. By the end of 1913 more than 200,000 tons of spelter, 20,000 tons of lead,

100 tons of copper, and some 5,000,000 oz. of silver were added yearly to the world's wealth by flotation, according to Hoover. The same writer estimated in 1910 the average flotation costs of zinc tailings by four processes (Potter-Delprat, de Bavay, Minerals Separation, Elmore), at Broken Hill at 3*s.* 7*d.* per ton, allowing a total of 9*s.* 3*d.* (including royalty of 1*s.*) for the treatment of 1 ton of tailings. These uncertain figures, which comprise heavy transport and labour charges, were indirectly deduced from company reports; they varied in items, but very little as to the total flotation costs by the four processes. In the United States flotation hardly obtained a foothold before 1912. At present Rickard estimates that some 50,000 tons are daily submitted to flotation over there. The Broken Hill Proprietary Company treated in the year ended November, 1915, 280,867 tons of tailings and produced 68,985 tons of spelter, the totals since 1904 being 2,988,919 tons of tailings, yielding 744,816 tons of spelter. The list of ores admitting of flotation treatment is constantly being extended.

Since the foregoing was written the August Bulletin of the American Institute of Mining Engineers has brought two more papers on the subject. The first is "An Explanation of the Flotation Process," by Professors A. F. Taggart and F. E. Beach, of Yale University, New Haven, dealing with the theory and describing some instructive experiments. One of their factors to which we have not drawn attention is viscosity. The presence of finely-divided matter increases the viscosity of the interfacial film. Thus, when powdered sulphide is thrown on oil floating on water, it settles on the interface between the two liquids, becoming entangled in the film. Gas bubbles rising from below through the water stretch the film and surround themselves in the oil with a skin of water and oil; the skin is thickened towards the bottom of the bubble by gravity, and also takes up the sulphide particles; such bubbles coalesce very slowly afterwards on the surface of the oil, where they may live for weeks. The second paper is a first account of experiments on "Miscellaneous Wood Oils for Flotation," conducted in Utah City by Messrs. R. C. Palmer, O. C. Ralston and G. L. Allen, representing respectively the Forests Department, the Bureau of Mines, and the Shattuck Arizona Copper Company. Some of the oils tried were rather tars or aqueous solutions of pyroligneous acid than oils, having been obtained by destructive distillation of hard wood. The pine-oil so much used for flotation, we should add, is not the oil obtained from turpentine (the sapwood resin of the living pine), but the oil obtained by treating the dead hardwood with steam or dry heat. Most of the tar oils were heavier than water, one of them having the density 1.4. Pine oil is essentially a terpenol; the composition of some of the oils experimented with was hardly known. The experiments were made with various ores, galena, zinc ores, mixed copper ores, pyrites and tellurides of gold and silver being also present. The oils were added in quantities from ¼ lb. up to 20 lb. per ton, in acid, alkaline and neutral solutions; the Utah water used is itself slightly alkaline. Good results were obtained with the relatively cheap oils; for zinc flotation acidity seems desirable, for differential flotation of galena, alkaline or neutral solutions of pyroligneous acid answered best. Gold ores were successfully treated, and Utah copper was floated best in alkaline solutions.

THE PANAMA CANAL.—Excavation from the bases of the Culebra slides during the week ended at midnight, Monday, June 19, says the *Canal Record*, amounted to 254,218 cub. yards. The aggregate of primary excavation from the bases of the Culebra slides since October 14, 1914, when such work was begun by the dredging division in the sections north of Gold and Contractor's Hill, to midnight, June 19, has amounted to 14,992,636 cub. yards.

SWEDISH EXPORTS OF IRON ORE.—Whilst the exports of Lapland ore have been much interfered with by the war and show a material decrease, those of Grängesberg ore from Central Sweden have been kept up on a substantial scale. Thus the shipments of Grängesberg ore by way of Oxelösund during the month of May amounted to an aggregate of 101,323 tons, which is stated to be a record figure. It is no secret that Germany is very hard up for iron ore, and even at a considerable risk she is keeping up her imports from Sweden.

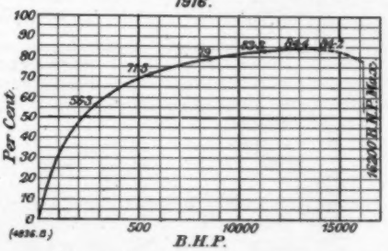
THE SWEDISH STATE HYDRO-ELECTRIC POWER STATION AT ALFKARLEBY.

(*Concluded from page 54.*)

IN our last article we dealt with the general arrangement of the turbine plant. As there explained the output of each unit was stipulated in the contract to be normally 11,250 brake horse-power at the lowest possible head of 15.6 m., but a further stipulation called for an output of 15,000 brake horse-power at 17 m. head. As is shown by the official test curve, Fig. 30, below, the actual output obtained at 17 m. is 16,200 brake horse-power Having regard to the fact that the shaft is horizontal, and that there are thus great losses on account of the unfavourable suction casings (as compared with a straight vertical exhaust) the efficiencies obtained are remarkably good, and were only possible of achievement by the most careful and exact design. The great size of these turbines will be better appreciated by reference to Fig. 31, page 172, in which are given diagrams, all drawn to the same scale, of the turbines at Niagara, Trollhattan, Augst-Whylen, and Alfkarleby. In addition there is stated on each diagram the horse-power the turbine would develop at a head of 1 metre.

The turbine wheels proper are cast solid in steel and are a remarkable piece of workmanship when dimensions are considered (Fig. 32, page 172). The

Fig. 30. EFFICIENCY CURVE FOR THE ALFKARLEBY TURBINES. OFFICIAL TEST ON THE 15TH-16TH APRIL 1916.



average diameter is 80 in., the largest diameter 8 ft., and the height 5 ft. The weight of one wheel is 5 tons 12 cwt. Figs. 15 and 16, in our previous articles (page 52 *ante*), show the general design of the turbines, as well as most of the details. The end rings of the guide apparatus are interconnected by 12 strong hollow stays lending rigidity to the whole system. These stays are connected to a steam supply system, with a view to supply heat during special conditions in winter time when the turbines are threatened by ground ice. The water passing over these heated stays into the guide apparatus receives a very slight increase in temperature, which, however, is quite sufficient to ward off the danger of sudden icicle formation. All the bearings have ring lubrication, the front and the centre being fitted with four rings each, and the back bearing with two rings. All the bearings are further accessible during operation by tunnels built in the concrete walls and leading from the power house.

The regulating arrangement is of particular interest, consisting of cast steel vanes moving on steel bolts (removable from outside), hollow regulating rings (one for each guide wheel) moving on rollers and filled with grease, and link connections between the rings and the vanes. Two strong 9-in. steel shafts running alongside the whole of the turbine are connected by double cast steel levers and links to each regulating ring, and further connected by cast steel levers and adjustable rods to the centre regulating shaft in front of the turbine (see Figs. 17 and 18) which is directly actuated by the servo-motor of the governor.

The general arrangement of the automatic governor is shown by Figs. 34 and 35, page 173. The capacity is considerable, as it is capable of exerting an effort of 1,650,000 kg. cm. during its full stroke; as this occupies a time of about 2 seconds it corresponds to an output during that time of about 110 brake horse-power.

Fig. 34 shows a section through the servo-motor and further details of the pipe system, governor pendulum, distributing valve, double relay compensation arrangements and hand regulation. The servo-motor is actuated by oil pressure derived from a rotary pump which delivers the oil into an air vessel of ample dimensions, a suitable safety-valve being fitted between the pump and air vessel. The two pistons of the servo-motor are rigidly connected together, and between them they carry, mounted on a pin, a die which fits the slotted jaws at the end of an arm on the main regulating shaft which controls the guide blades of the turbine. Oil under pressure is admitted to the outer side of one or other of the two pistons according as the speed is above or below the normal. The control is effected by a valve in the base of the centrifugal governor standard, which connects one end of the servo-motor to pressure and the other to exhaust as required. In addition there is an "overtaking motion" worked by a rod on the end of the motor piston and tending to return the valve to its central position. There is, further, a second compensation in the governor itself to render the speed nearly constant at all openings of the guide blades. A rocking motion driven by a band from the governor spindle keeps the controlling valve in constant vibration to prevent all possibility of its sticking. Each turbine unit has a complete pumping set and air vessel, but all units are interconnected, so that it is possible to operate any servo-motor from any air vessel.

The automatic regulation is very exact, as will be noticed by diagrams shown by Fig. 33, page 172. These diagrams are copies of those taken at official tests, and obtained by an automatic tachograph. It will be observed that the maximum variation in speed, whilst throwing off full load 13,000 brake horse-power to no load instantaneously, is 12 per cent., and that, on the other hand, throwing on full load from no load decreases the speed by 9 per cent. The remaining variation after the momentary deflection is, however, only ± 2 per cent., which is achieved by the second double compensation.

The whole of the governor arrangement shows an interesting development of the original Boving governor as designed in the year 1900. It further shows that modern automatic regulation for these huge water turbines is as accurate and sensitive as for steam prime movers.

The Alfkarleby power-station is located in a district of Sweden where there are large demands for power. The two provinces Uppland and Södermanland have but little water-power, and in Västmanland the capacity of the few unimportant streams has practically all been exploited. The requirements of the city of Stockholm and its immediate surroundings will be supplied by the large municipal hydro-electric power-station at Untra, now approaching completion; other power consumers—and they are the majority—have to content themselves with heat-generated power where electric energy from the Alfkarleby power-station is unobtainable. The Alfkarleby station has consequently met with a large demand for energy, and the sale during the present year is likely to reach a maximum of about 300,000 kw.-hours per 24 hours, and next year a maximum of 500,000 kw.-hours per 24 hours is anticipated. It may, in fact, be safely asserted that within a very few years the power-station at Alfkarleby will be taxed to its fullest practical capacity, which means a supply of some 170,000,000 kw.-hours per annum, representing a yearly consumption of 150,000 tons of coal, had this amount of energy been produced by steam.

The area supplied from the Alfkarleby power-station, shown by the map, Fig. 36, page 173, which at present comprises Uppland, southern Gästrikland, south-eastern Dalecarlia, eastern Västmanland, and northern Sodermanland, is already much larger than any of the distribution areas which any of the older Swedish power-stations has attempted to supply. Should a contemplated co-operation between Alfkarleby power-station and the power-station on the Motala River be brought about, the former power-station will supply over a distance of 200 km. to 250 km. (125 to 156 miles), from southern Norrland to northern Götaland.

At what would normally be the southern terminus of the supply area of the Alfkarleby power-station, that is, the distribution area north of Lake Mälären—a steam power-station has been erected

at Västeras, which completes the Alfkarleby distribution scheme, and equalises the power supply at times of low water. In the future, as the Alfkarleby system extends, this steam power-station will occupy an almost central position. In the course of the next few years it probably will be extended up to a capacity of 42,000 kw.

The energy from the Alfkarleby power-station is employed for the following industries and purposes:—

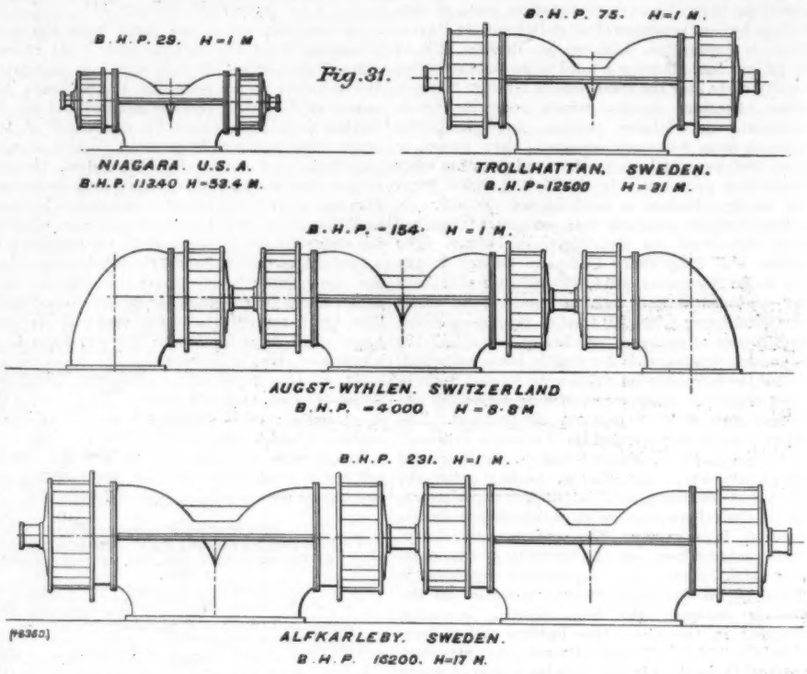
	Consumption in per cent. of the Total Kw.-Hrs. Consumed.	Consumption in per cent. of the Maximum Kilowatts.
1 Paper mills, wood pulp, sulphate and sulphite works	35.0	25.0
2. Electro-metallurgical purposes ..	30.0	17.5
3. Municipal electricity works for re-distribution	10.0	17.5
4. Mining and iron works	10.0	15.0
5. Manufacturing, engineering, &c. (direct supply)	7.5	10.0
6. Rural distribution, agriculture, flour mills, brick-making, &c. ..	7.5	15.0
	100	100

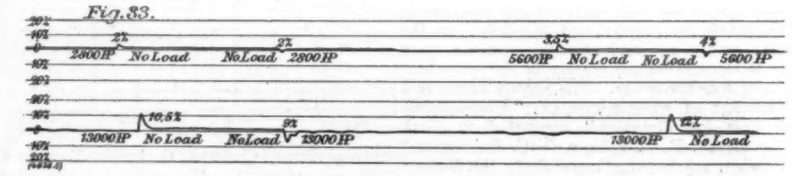
The above table does not include any energy which may be required for railway electrification, for which purpose some 10 per cent. of the total production might be used, and the other figures would have to be correspondingly reduced. Contracts with the more important consumers have been concluded up to a total quantity of about 31,000 kw.

The system of distribution is shown by Fig. 36, on page 173. For the local 20,000-volt distribution round Alfkarleby, the Waterfalls Board have constructed overhead lines to Gäfle, Karskär, and Tierp; the consumers have undertaken the construction of lines to Skutskär and Söderfors. The long-distance distribution in the northern direction is effected by means of a 40,000-volt line, which at present proceeds *via* Forsbacka, Storvik and Hofors to Stjärnsund. Later on the line may be continued *via* Hedemora to Västeras. In this northern district the load points, mostly iron works, are but a short distance apart and each takes about 500 kw. The Waterfalls Board first planned a 70,000-volt distribution system for the northern district as well as for the southern, but it was found that the future load requirements did not justify this comparatively high voltage. On the northern line all the sub-stations, except that at Forsbacka, have been built by the consumers. In the course of the present year the sub-stations at Forsbacka, See, Storvik, Hofors, Stjärnsund, and Langhyttan will be in full work. The 40,000-volt lines have been constructed by the Waterfalls Board, except the Stjärnsund-Langhyttan line, which has been built by the Kloster Company.

For the southern distribution system a primary voltage of 70,000 to 77,000 volts was chosen, this high voltage being necessary, as most of the energy has to be transmitted a distance of from 100 km. to 200 km. (62.5 to 125 miles). The voltage was, however, limited by the necessity for a number of relatively small transformer-stations with capacities of a few thousand kilovolt-amperes, as well as by the difficulty of obtaining, within the country, suitable materials for a higher voltage. The fact that there is a reserve steam-power station in the southern portion of the distribution area, which station, if required, can work as a synchronous-motor station, naturally increases the load capacity of the main line from Alfkarleby to Västeras, and, at the same time, reduces the need for a higher voltage than that chosen. The southern distribution line is therefore constructed for a working pressure of 70,000 volts from Alfkarleby, *via* Dannemora, Upsala, and Enköping, to Västeras. A branch line, for 70,000 volts, has been laid from Dannemora to Hallsta, and another 70,000-volt branch line is in course of construction from Enköping to Strängnäs. The latter line will probably have to be extended, at 70,000 volts, on one side to Eskilstuna, and on the other side to Södertälje, and possibly further south to central Södermanland. All the 70,000-volt lines were built by the Waterfalls Board. Step-down transformer stations have been constructed by the Waterfalls Board at Dannemora, Hallsta, Upsala, Enköping, and Västeras, and another is being erected at Strängnäs. The secondary pressure is 20,000 volts for the urban systems, 3000 to 6000 volts for the towns and large industries close to the transformer stations, and 40,000 volts for the lines which are now under construction to Eskilstuna and Södertälje. Important subsidiary lines are in course of construction, and will soon be ready, to Dannemora mines, the Osterby works, the Schebo iron works, to Herräng and Märsta; secondary lines to Sala, Eskilstuna, Aker, and Nyqvarn have also been decided upon, and they will be ready early this year. A line to Teda, close to Enköping, is ready for working, and other rural lines will be constructed to supply Sigtuna, Venngarn, Rasbo, and other places. All these 20,000-volt lines are being built by the Waterfalls Board. A large

SWEDISH HYDRO-ELECTRIC POWER-STATION AT ALFKARLEBY.





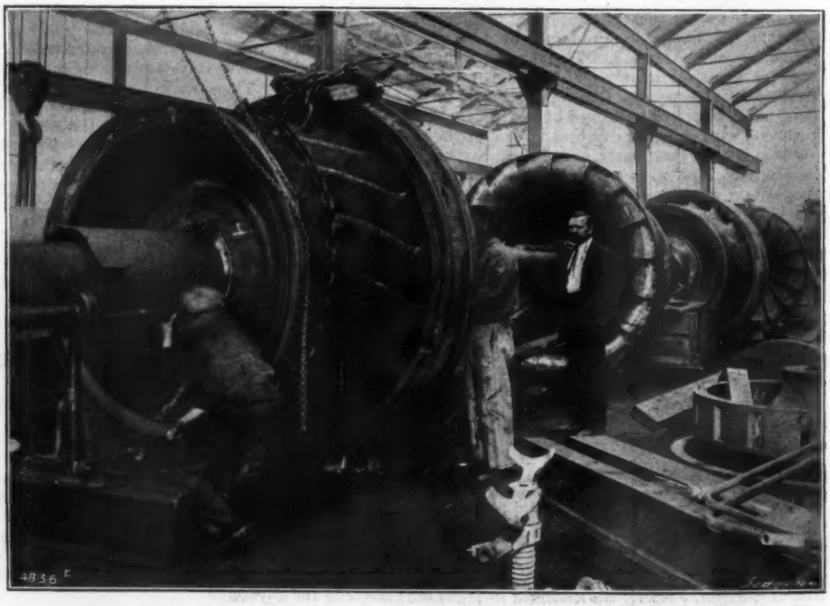
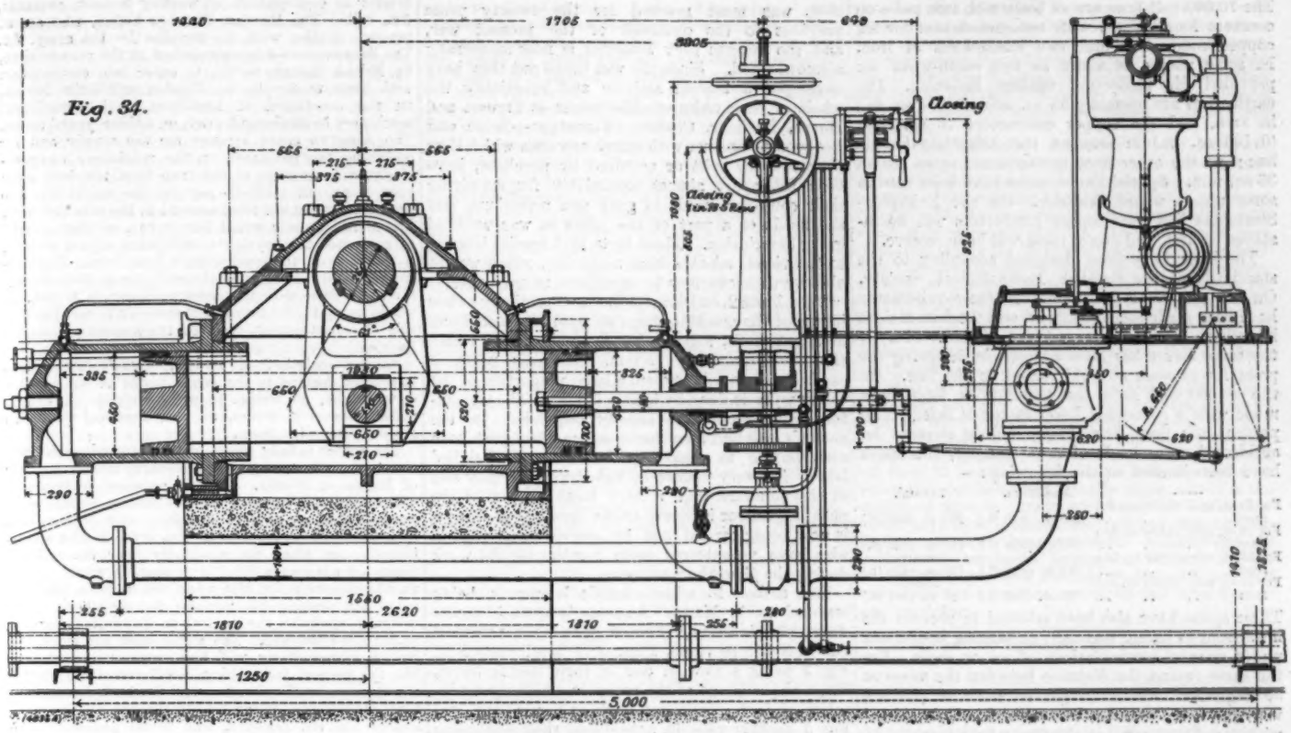


FIG. 32.

THE SWEDISH HYDRO-ELECTRIC POWER-STATION AT ALFKARLEBY.

Fig. 34.



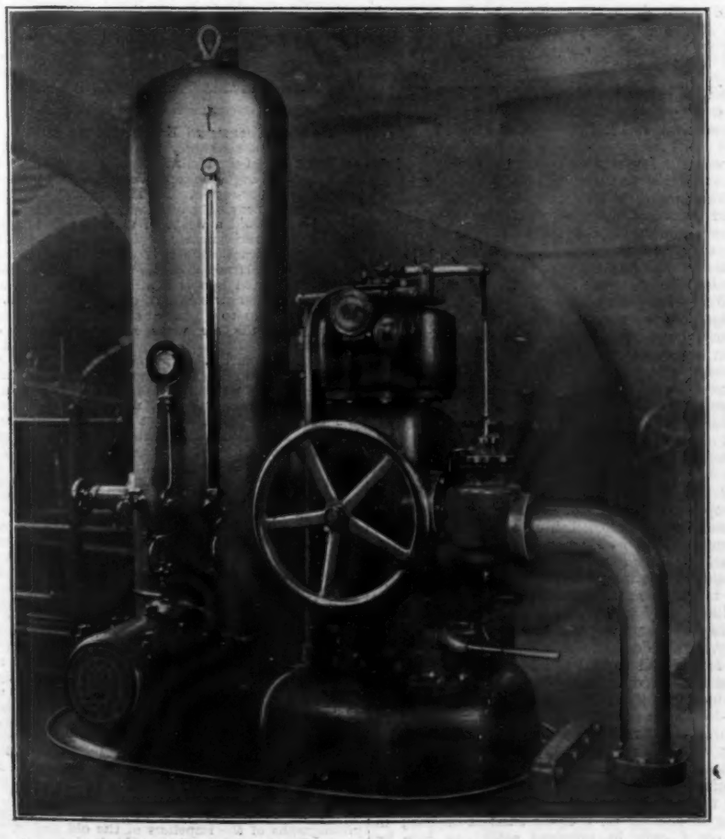
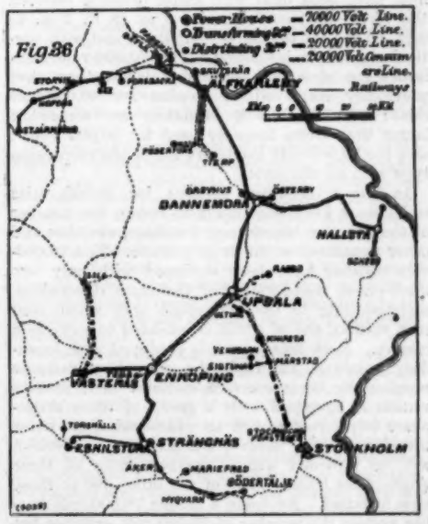


Fig. 35.



rural distribution system, on the co-operative plan, has already been constructed close to Enköping, and simi ar co-operative systems have been decided upon and partly put in hand at Old Upsala, Rasbo, Tierp, Häfversösund, and Knifsta. For these systems the pressure used is 1500 volts, and this is further r.duced to 220 volts for motors and to 127 volts for incandescent lamps.

All the 20,000-volt lines are constructed with wooden poles, provided with earthing wires on the more important routes. Oak poles have generally been used, as under the present disturbed conditions impregnated poles were unobtainable. Th 40,000-volt line from Alfkarleby to S järnsund has been constructed with A poles of fir on concrete bases. The line is at present equipped with three copper conductors, each 35 sq. mm. (0.054 sq. in.)

in area, and one earth-wire of iron of the same sectional area; but space has been left for a fourth conductor, which will be provided and used as a reserve. The 70,000-volt lines are all built with iron poles on concrete foundations, with accommodation for six copper conductors and two earth-wires of iron. In some places as many as five earth-wires are provided for protection against lightning. The earth-wires are normally 35 sq. mm. (0.054 sq. in.) in area, and the copper conductors 70 sq. mm. (0.108 sq. in.) in area on the Alfkarleby-Upsala line; on the other lines the sectional areas are all 35 sq. mm. Special line sections have been used in some places where desirable. On the Enköping-Strängnäs line four copper conductors will be installed at first, and one of these will be in reserve.

The lines have been designed according to the standards of the Swedish Technological Society. On the 70,000-volt lines, however, the requirements have been made more stringent, and the foundations have been calculated for a factor of safety of five; the same factor has been adopted in designing the poles for stresses at right angles to the line. On the 40,000-volt lines the foundations have been made with a somewhat lower factor of safety. To prevent the lines from being unduly stressed by accidental extra loads of snow and ice, the spans have been limited to the following:—

	Maximum.	Normal.
For 70 sq. mm. (0.108 sq. in.) lines	265 m. (870 ft.)	200 m. (656 ft.)
For 35 sq. mm. (0.054 sq. in.) lines	170 m. (558 ft.)	160 m (525 ft.) about
For 25 sq. mm. (0.039 sq. in.) lines	125 m. (410 ft.)	125 m. (410 ft.) about
For 16 sq. mm. (0.025 sq. in.) lines	80 m. (262 ft.)	80 m. (262 ft.)

These spans have also been selected to prevent the lines from swinging together, or sagging irregularly under uneven accumulations of ice or snow. For the same reason the distance between the wires at 50 deg. Cent. was increased to 6.75 m. (22 ft.), with the 70-sq.-mm. conductors, and to 7 m. (23 ft.) with the 35-sq.-mm. conductors where suspension-type insulators were employed. Elsewhere the lines have been built with ample distance between the wires—that is, 2.5 m. to 3 m. (8 ft. 2 in. to 9 ft. 10 in.) for the 70,000-volt lines, and with particularly ample insulation. The 20,000-volt insulators are of a type somewhat larger than that previously employed in Sweden for 40,000-volt lines; the 40,000-volt insulators are somewhat larger than those formerly used for 50,000 volts; and the 70,000-volt insulators are of the suspension type with six elements.

In the transformer stations for 70,000 volts endeavours have been made to reduce the number of the primary transformer windings, switches and other apparatus as much as possible. The 70,000-volt stations have been equipped with only two three-phase transformers of the same dimensions, corresponding to the two single lines which feed each station, one of which is intended to serve as a reserve. Each transformer is equipped with secondary windings for both the secondary voltages supplied by the respective stations. The Hallsta station is equipped with a group of three single-phase transformers, with an additional single-phase transformer as a reserve, and for future extension will be provided with a further group of three single-phase transformers of the same size as those now installed. By using a simple 70,000-volt bus-bar system the number of 70,000-volt switches has been reduced to two, and by inserting current transformers with return-current relays for the incoming lines, the cutting-out of a single faulty line can be effected without disturbing the working of the station. Beyond earthing resistances for the neutral points of the transformers, and earthed voltage transformers for the delta-coupled systems, no excess-voltage protection has so far been installed.

MESSRS. SCHNEIDER'S GUN, MUNITION, AND ARMAMENT WORKS.

We illustrate in Figs. 1 to 7, on Plates XIX to XXI, in the present issue, various shops of several of the works owned by Messrs. Schneider and Co., in different parts of France. In two former issues (see Engineering, vol. c., pages 535 and 559) we gave an illustrated description of their type of light, horse artillery, 75-mm. (2.953-in.) and of their 105 mm. (4.134 in.) type of field guns. Their activity in this class of work, which dates from the period of the French Revolution, was most marked for the twenty years previous to the outbreak of the present war, and the success they achieved is now universally acknowledged. Since the war broke out they have developed a tenfold activity and practically the whole of their older establishments at Creusot and Havre, Harfleur, Chalon, Champagne-s-Seine and Bordeaux, together with many new ones which they have recently built or acquired by purchase, have been set apart almost exclusively for supplying their country's needs in guns and munitions, and the needs of a part of the Allies in war work of every description. These facts lend special interest to the views, selected from a number, which we are able by their courtesy to reproduce in our pages.

Figs. 1 and 2, on Plate XIX, are respectively a view in one of the machine-shops set apart for machining field-gun shells, and a view in another shop where the machining of 75-mm. field-guns parts is conducted. As will be seen, a large proportion of the easier work is done by female labour. The women-folk of France have eagerly responded to the nation's call and have for many months past been contributing to make up for the lack of skilled labour in every branch of industry. We may add at this juncture that a very large portion of the unskilled labour in many trades throughout France is now being carried out by natives from Algeria who have volunteered their services for the work during the time the war lasts.

The extent to which female labour is being resorted to in Messrs. Schneider's establishments distributed in various French cities is more marked still in the three views, Figs. 3 to 5, of Plate XX, Fig. 3 being a view in one of their fuse factories, Fig. 4 showing one of the rooms in which the verification of fuse component parts is carried out, and Fig. 5 another view in a field-gun shell-machining shop. The heavy work is still being done by men, such, for example, as the manufacture of heavy projectiles and the forging, assembling and machining of guns. Fig. 6, on the same plate, illustrates the forging of the head of a projectile, and Fig. 7 on Plate XXI is a view in a gun-machining shop.

AGRICULTURAL MACHINERY IN RUSSIA.

Below we continue the series of notes received from a correspondent who has just returned from abroad.

The writer, a few months before the outbreak of the present hostilities, had the pleasure (it was a pleasure) of meeting in Siberia one of two German brothers who had gone out there about three years before. In conversation he learnt that on their arrival in Siberia they had taken a small farm to gain the confidence of the farmers and peasants. They then entered into an agreement with the farmers in the surrounding districts to supply them with technical knowledge how to increase the output of their land, the German brothers to be recompensed by being paid a certain percentage of the *extra* crop thus secured. They arranged to supply the farmers with the latest agricultural machinery, the payments on the machinery to be completed in three years, a certain percentage of the *total* crop to be paid each of the three years towards the cost of the machinery. Where chemical fertilizers were recommended, these were bought from the German brothers, and with the extra depth turned over by the machine plough there was always an extra crop, so that the risk of their arrangement to them was very small. On being asked if the Siberian Government officials had in any way proved obnoxious, he replied: "They have been nothing but courteous in the past, and as we are selling out this farm in two months to go to another part of the country, it is hardly likely they will give any trouble before then, but if they did, and we were compelled to return to Germany, we should really be indifferent, as the return for our labour and capital has been so great that it would be no hardship if we had to return to Germany."

If the income of these German agricultural machinery agents—for they were nothing else—was so great that they could talk of retiring after three years' business, it surely will well repay the British manufacturer of agricultural machinery to push his business in Russia and Siberia, which is really a very fine country. Before the war there was great difficulty in arranging about supplying machinery on a credit basis in Siberia; in fact it could only be arranged safely, as done by those German brothers, by having a personal representative in the district. *Now*, conditions have altered greatly, but the opportunity to utilise the altered conditions must be seized before the conclusion of hostilities. There has been formed in each district of Russia and Siberia an organisation of wealthy farmers, peasants, &c., called The Russian Zemstvo Union, who are at present dealing with the supplies for the army, &c. The Zemstvo could be approached at the present time, by British manufacturers, to enter into co-operation with them to supply the Russian or Siberian farmer, on the conclusion of hostilities, with agricultural machinery or implements, say, on a three years' credit. The Zemstvo could arrange for the supply and for collecting the payments on the machinery co-operatively, a percentage of the crop from the farm each year being put aside to pay for the machinery, the Zemstvo paying the total amount to the manufacturer. The manufacturers would thus have a wealthy society to guarantee the payments, and, being a local society, it would know the conditions of each farm. Manufacturers would require to amalgamate and to deal through a central office with the Zemstvo Union in Russia. It would be up to the British Government to see that this ring of manufacturers received the necessary financial backing.

Similar societies, of traders, manufacturers, &c., have been formed in the larger towns in Russia, and it would be, no doubt, to the advantage of British manufacturers of steam, oil and electrical plants to get in touch with them.

The writer is fully aware of the tremendous difficulties there are in transporting machinery into the interior of Russia or Siberia. On one occasion he travelled with a trader, who had been into Moscow for his year's supplies, who had to do a five days' train journey and then 800 miles on horseback. But if the British manufacturer can place his machinery near the railway routes or waterways for the present, it would act as an advertisement for him when the facilities are provided for pushing his business further afield. This will also apply to the neutral or disinfected German trader after the war. The writer does not think the British manufacturer will find another opportunity like the present for making arrangements to supply the Russian or Siberian farmers' demands for agricultural implements, in the future, through an organised society like the Zemstvo, who would guarantee the payments. Our Eastern Allies are beginning to comprehend the vast possibilities of Eastern Russia, and the political alliance recently signed is only a slight outward indication of the many agreements that are being made between the manufacturers and traders in the two countries. Passing through America the words "*Do it now*" are noticed almost everywhere. If the British manufacturer wishes to secure a fair amount of the trade in Russia he must "*Do it now.*"

The Air Supply to Boiler-Rooms on Warships.—In a pamphlet recently published, Mr. R. W. Allen, M.Inst.C.E., of the Queen's Engineering Works, Bedford, has collected together some valuable data on the supply of air to boiler-rooms. He lays special emphasis upon the need of providing ample and unobstructed airways in order to avoid a waste of the head generated. The head wasted varies nearly as the square of the air velocity, as it is not practicable to reconvert into pressure head any substantial fraction of the velocity head of the moving fluid. Mr. Allen quotes a number of cases of excessive velocities in the air shafts of different warships, ranging from 48 ft. up to 78 ft. per second. In practice a high velocity in the air ways means that the effective gauge in the boiler-room is reduced by the head equivalent to this velocity. With such an air speed as 78 ft. per second this reduction amounts to 2 in. That these excessive speeds are not unavoidable is shown by the quotation of other figures, where even on destroyers the air velocity has been kept down to 42 ft. per second. In certain cases the air shafts have been thought convenient places for the storage of hose, &c. In other cases pipes have been led through them, with little or no consideration to the consequent obstruction of the airway. Again, the openings above-deck are often far from as free as is desirable. Deck erections, for example, may obstruct the access of air to the whole of one side of the intake, and some instructive examples of this are given. The armour bars or gratings are also commonly of bad form. Experiments made at Bedford with bars of "fair form" instead of rectangular showed with the fair form a zero pressure drop across the grating, whilst with the rectangular bars the loss of head due to the obstruction was 0.22 in. (water gauge) with a velocity of 53.7 ft. per second. Mr. Allen states that when two fans are mounted close together their performance can be greatly improved by fixing appropriate deflector plates, so that the air currents as delivered shall not interfere with each other, and similar plates have also proved advantageous even with single fans, tests made with ribbons in the boiler-room having shown that in many cases the air is far from taking the most direct line to the furnaces. In conclusion, Mr Allen draws attention to the great progress which has been made of recent years in fan design, which he illustrates very strikingly by comparative photographs of the impellers of the old and of the new type. The same duty is now obtained from an impeller 52 in. in diameter as from one of 81 in. in diameter a few years ago.

INDUSTRIAL NOTES.

The monthly report for the present month of the United Society of Boiler Makers and Iron and Steel Shipbuilders makes the following remarks: ". . . Our percentage of unemployment is the lowest on record. Our skilled men are urgently required by the nation at the present time, both on the field and in the factory. The number of our men absorbed in the Army and on vessels of war is reflected in the ship-building returns for the last seven months. In our largest shipbuilding district the total output of merchant ships for seven months is 74,785 tons. This is less than half the output for the corresponding period of last year and only one-fourth the output of the same period for 1914, and less than one-fifth of the output of the same period for 1913. In the minds of the public there was some alarm that the German submarines were the most serious menace to our shipping, but from Lloyd's returns the total war losses to British shipping in the quarter is less than ½ per cent. . . . The length of the war and the cost of the war in money and lives have exceeded all expectations. . . . The duty of our soldiers is to kill the enemy, or to render as many as possible unfit to fight, and in this we at home must do all we can to supply them with the most deadly weapons for this purpose. . . ."

In this connection it is interesting to put on record a few statements made by an invalidated British Army chaplain. After paying a tribute to the most admirable and most disinterested way in which our men act in every respect and in every situation at the Front, even when they are wounded, the chaplain concluded as follows: ". . . Do you know what have become the most beautiful material objects in the world to my eyes? Shells, guns, munitions. Why? Because they are substitutes for the most precious flesh and blood in the world; the flesh and blood of our truest Christians. The more we have of the one, the less we need to sacrifice of the other. That is why the deadly things have become of all things the most beautiful in my eyes. That is why if I were not the servant of our men in another capacity, I should be working in a munition factory at home to-day."

In the quarterly report for April to June now issued by the Shipconstructors' and Shipwrights' Association, the following statements are made: ". . . The readjustment of things after the war is a subject which must be well thought out and to which organised labour must give its undivided attention. While we must prosecute the war to a successful termination, we cannot afford to wait for that event. It is necessary that labour should be so prepared that when the opportunity arises we will be ready to show that organised labour has clear and definite proposals, not only as to wages, conditions of employment, hours of labour, but as to the organisation of industry, its control and its development from a national standpoint, in the general interest of the community. . . . The war has changed the outlook in many directions. Labour must now show, by its broad national views, that its claims to be heard in a larger measure in all that affects the interest of the country and the Empire is based on its ability to govern, not in a parochial sense, but in a national and international sense. . . . The reward of labour must not be left, as at present, to the operation of supply and demand alone; a minimum wage for all workers must be arranged, and upon that all other charges in the production of anything should be based and built up, and that having been done, labour can join with employers in seeing that wages are maintained and not reduced by sweated and unfair competition from abroad. . . . Another important matter on which too much attention cannot be directed is the question of education and the training of our apprentices in their various callings. . . . With the requirements of our Navy to be met, it was only to be expected that trade would maintain a high level, and our members generally have been fully employed. Although, for obvious reasons, no information is available with regard to war work, it is interesting to record that according to Lloyd's returns there were 440 merchant vessels of 1,540,218 tons under construction at the end of June, being 117,000 tons more than the previous quarter and about 33,000 tons more than for the same quarter of 1915. . . . The income of the Association for the quarter has been 22,943*l.* 3*s.* 11½*d.*, whilst the expenditure was 17,687*l.* 7*s.* 6½*d.*, leaving a net gain to the funds of 5,255*l.* 16*s.* 5*d.* which, added to the balance in hand, brings the reserve fund at the end of June up to 183,818*l.* The total membership at the end of June, 1916, was 30,250. . . ."

As a result of the training received at the Municipal Technical Schools at Suffolk-street, Aston, and Handsworth, says the *Birmingham Daily Post*, some hundreds of Birmingham men and women have joined the great army of munition workers. The local Education Department is working in conjunction with the Ministry of Munitions. Owing to the large number of persons desirous of undergoing a course of training, it was necessary to have a waiting list. This is now becoming exhausted, and the authorities are anxious to receive the names of those who are prepared to enrol as students. It is pointed out that there are opportunities for better-class women to take part in this important work. At Aston and Handsworth classes for women, as well as men, have been held for some time, and arrangements are now being made at Suffolk-street for the training of women. Firms who have been supplied with women workers have written acknowledging the admirable manner in which they do their work.

In each of the three schools there are four shops for the training of munition workers. The first is the general shop for preliminary training in bench and tool work. From that shop students who show special aptitude are drafted into the other shops for instruction in gauge making, tool setting, and tool turning. Such students give their whole time, and are paid 2*l.* per week maintenance allowance, and when the training is completed they are placed by the Ministry of Munitions in works where their services are needed. At the present time gauge makers, in particular, are required, as well as those proficient in making and setting tools, and in these directions the training given at the Birmingham schools has proved most valuable.

The Commission of Canadian business men who are on a visit to this country with a view to improve trade with Canada were received last Monday at the Philosophical Hall, Leeds, by the Chamber of Commerce and a number of business men. In the course of a speech he made to the meeting, Mr. Woods, representative of the wool industry in the Commission, said that, after all, trade with Canada was a question of tariffs, and the Commission hoped that when the war was over there would be an arrangement which would make for the greatest possible amount of trade being done between Canada and the Mother Country. Canada wanted to shut German goods and Germans completely out of the market. Canada was thinking of the treatment which our men who were prisoners in Germany were receiving. There was a feeling wherever the Commission went that in the arrangements for shutting out all German goods, calm, businesslike judgment would be exercised, to the exclusion of feelings of revenge or passion. In Canada it was found that a surtax against German goods operated very effectively. When Canada gave the preference to British goods, Germany put on a surtax, and Canada replied with one against Germany. That reduced imports from Germany in one year by 50 to 60 per cent. The surtax was removed in 1909, but it took until 1913 for German trade to get back to the point at which it stood when the surtax was proposed. The Commission hoped, when matters were being adjusted after the war, that there would be a substantial preference within the Empire, a reasonable tariff being charged against neutrals and a very high one against the enemy. That feeling was the one which prevailed throughout Canada. "We feel," concluded Mr. Woods, "that the Empire has been drawn together by this war in a way that would never have been possible; that there is throughout the Empire a strong desire to co-operate, and while each part should be allowed to adjust its own affairs in its own interests, it should never be forgotten that there are general Empire needs and possibilities."

The application of the Standing Committee of the Shipyard Trade Unions for an increase in wages was heard by the Government Committee on Production in London last Friday, the 18th inst., Sir George Askwith presiding. The Boilermakers' Society are asking for 6*s.* per week advance for time workers and 15 per cent. for piece workers, whilst the allied trades ask an all-round increase of 15 per cent. We understand that the application had already been before a Central Conference between the Standing Committee and the Shipbuilding Employers' Federation, and had been refused by the employers. The men urged that their claim was justified by the increased cost of living; the employers replied that the increased cost of production prevented them from considering the men's request. At the close of the proceedings last Friday the Press was informed that the decision of the Committee on Production will be announced in a few weeks.

Mr. A. L. Humphrey, of the Westinghouse Air Brake Company, Wilmerding, Pa., dealt with the manufacture of munitions in a lecture he delivered on May 31 at Pittsburgh. The lecture is reproduced in *The Iron Age*. Among Mr. Humphrey's statements are the following: ". . . It has been estimated that for every man needed at the Front to operate the machines of actual warfare there are needed three men at home to furnish him with the supplies for his operations. Thus for an army of 2,000,000 men at the Front, 6,000,000 men are needed in the workshops to keep supplied the men in active service. When one considers that there are not more than 3,000 truly expert gauge makers in the country, the point where they can render most effective service is fully apparent. The work of the Committee on Industrial Preparedness, then, is most wise in listing our skilled artisans that they may not be foolishly sent to the Front in the time of need and thereby impose starvation upon military operations.

"Let me here draw attention to the insidious, lurking dangers in the way of restrictive labour legislation that have become so manifest to the manufacturers of this country, who undertook at an enormous financial risk the manufacture of a commodity with which they were not familiar. The absence of laws governing the hours of labour and output, together with the hearty co-operation of their employees, enabled the manufacturers to inaugurate a system for increasing production and for rewarding their employees on the basis of individual skill and efficiency. I have been informed by the representatives of foreign Governments that the excellent results obtained from this system have amazed the world.

"Had the manufacturers of the United States been compelled to quote prices on ammunition contracts received from foreign Governments during the past two years under the restrictions imposed by our own National Government, it would have been necessary to bid from 25 to 50 per cent. higher than the prices at which the contracts were actually taken, and it is the opinion of those in a position to know that such prices would have been prohibitively high and that business would not have been procured. Unhampered by foolish laws, mechanics engaged in the manufacture of munitions have been able to earn 50 to 100 per cent. more than has ever been earned by the same class of men heretofore. . . ."

The Ministry of Munitions forward the following for publication:—

The Clyde Commission for the dilution of labour was constituted on January 22, 1916, as a temporary Commission to establish the principle of dilution in the Clyde District where special difficulties had arisen. It was originally contemplated that the Commission would complete its work in a few weeks. The task, however, has proved a much longer one than was anticipated, and when, on May 12, the scope of the Commission was extended to the Tyne, its term of office was extended for a further period of two months. The Commission has now made such progress with its task that it has become possible to continue the work on the Clyde and the Tyne on a somewhat modified basis.

Dilution has already been established in 150 of the largest of the 300 controlled engineering and shipyard establishments on the Clyde, and some 14,000 women have been introduced by the Commission, the greater proportion of whom are engaged on general engineering work, excluding shells. Agreements have been concluded for dilution in shipbuilding and ship-repairing yards on the Clyde and Tyne with all the principal shipyard trades; the interchangeability of members of different shipyard trades, and the introduction into the shipyards of unskilled men and women is proceeding satisfactorily.

Arrangements have accordingly been made whereby the current work of the Commission on the Clyde and Tyne will be taken over and continued as from September 1 by officers of the Ministry of Munitions and of the Admiralty, as in other parts of the country. In making this announcement the Minister of Munitions desires it to be generally known that the Commissioners have intimated their willingness to place themselves, individually and collectively, at his disposal after the Commission, as such, has come to an end, to deal with questions of difficulty arising out of agreements concluded on the Clyde and Tyne, and also to assist the Labour Supply Department of the Ministry of Munitions in applying the principles of dilution in other parts of the country.

The Minister of Munitions takes this opportunity of expressing his appreciation of the very valuable work accomplished by the Commissioners in circumstances of exceptional difficulty.

In another page of the present issue, when dealing briefly with Messrs. Schneider's ammunition works, we state that a number of natives from Algeria are now carrying out unskilled work throughout France. It is now reported that Chinese have also been landed in the country for the same purpose, whilst several thousand Portuguese workmen are on their way to work in the French factories.

Baldwin Locomotives.—The management of the Baldwin Locomotive Works has purchased a tract of 71 acres adjoining the company's present property at Eddystone, Pennsylvania. The land thus acquired extends partly into Ridley township.

MALLET LOCOMOTIVE FOR THE BALTIMORE AND OHIO RAILWAY.

CONSTRUCTED BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, U.S.A.

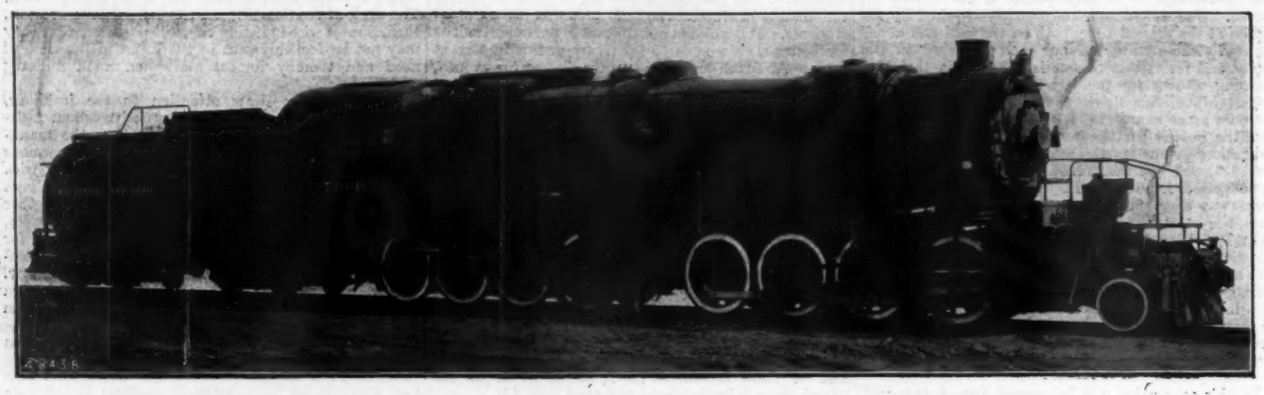


Fig. 1.

We have from time to time illustrated in our pages a number of examples of exceptionally powerful Mallet compound locomotives constructed for service in the United States, and to these we now add engravings of two recent types constructed at the Baldwin Locomotive Works, a firm who have had much experience in the development of this class of engine. The Mallet articulated type of locomotive has now been in use on American railways for about twelve years, and has proved itself a highly efficient form of motive power for certain classes of service. The failures which have, in some instances, attended the introduction of these engines have been due not so much to defects in design as to attempts to use the locomotives in performing work for which they were not suited. Furthermore, the necessity for using Mallet locomotives in road work is not as pressing now as it was shortly after the type was introduced. During the past few years it has been possible to increase the capacity of single-expansion locomotives, with only one group of coupled wheels, to such an extent that the tractive force of the largest ten-coupled engines now materially exceeds that of the first heavy Mallet locomotives built. The latter had six pairs of coupled wheels, divided into two groups of three pairs each.

The use of Mallet locomotives in the United States is now confined principally to three classes of work, viz., pushing service on mountain grades; switching service in "gravity" yards, where heavy trains must be pushed up one side of the "hump" before the cars are classified; and road service where conditions of operation are unusually severe and the traffic is moved at comparatively low speeds.

The illustrations on the present and opposite pages show two designs of Mallet locomotives which have been recently built by the Baldwin Locomotive Works. Locomotive No. 7109, for the Baltimore and Ohio Railroad, which is illustrated by Figs. 1 and 2 annexed, is one of 15 which have been specially designed for road service on the Cumberland Division. Conditions on this section of the line are unusually severe. The traffic consists chiefly of coal, which is moved in an east-bound direction over grades of 2.27 and 2.4 per cent. West-bound, against the movement of empty cars, there is a grade aproximately 20 miles long, the greater part of which rises 2.28 ft. per 100. Mallet locomotives of the 0-8-8-0 type have been used as pushers on these grades for several years, and the results obtained have been so satisfactory that the Mallet design has now been adopted for road service. As there are frequent curves on the line, and the new engines head the train, they have been equipped with two-wheeled leading bogies of the radial type. No rear bogie is used, as the engines are run chiefly in a forward direction.

The boilers of these locomotives are similar, in many respects, to those of the Nashville, Chattanooga and St. Louis Railway engines to be described later. The barrel is built with a conical connection, and there is a similar arrangement of combustion chamber and brick arch. The Street mechanical stoker is applied. With this device the coal is blown into the furnace, by means of steam jets, at three points, one on the centre line of the fire-box and one on either side. The Street stoker is used on a large number of locomotives of the 2-8-2, 2-10-2 and Mallet types on this road; and by its use full steam pressure can be maintained while the engines are working in the most severe service on mountain grades.

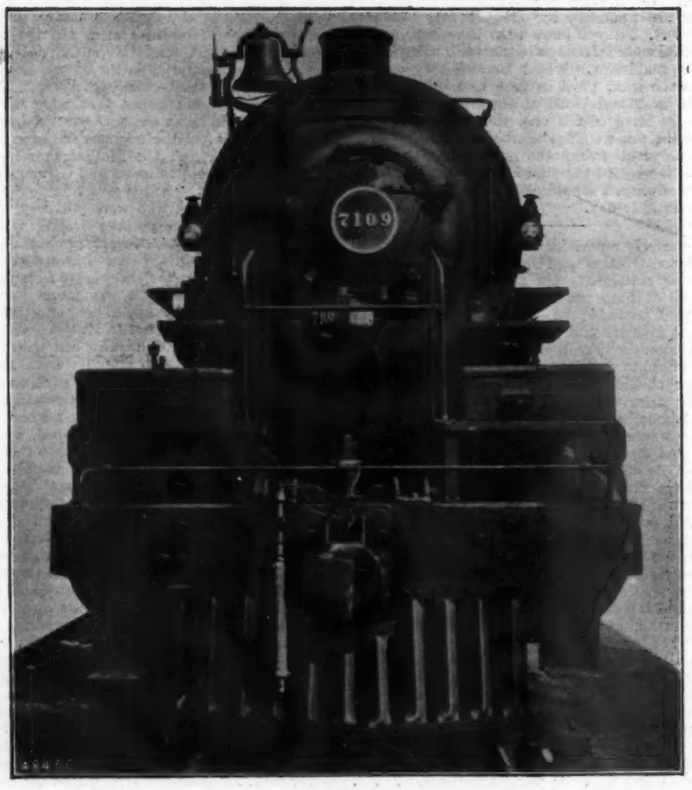


Fig. 2.

In the new Mallet locomotives the high-pressure cylinder saddle, and the upper sections of the two waist bearers over the front frames, are bolted to the boiler shell. Inside liners are used above the saddle and the waist bearers, and a tight joint is assured by electric welding around the edges of the liners and bolt heads.

The superheater is of the Schmidt type, and the general arrangement of the piping is similar to that used on the Nashville engines. The high-pressure distribution is controlled by inside admission piston valves, 14 in. in diameter, while the low-pressure valves are of the Allen ported balanced slide type. Walschaert's valve motion is used, and the gears are controlled by the Ragonnet power mechanism. Each high-pressure cylinder is an independent casting, and is bolted to the frames and to the central saddle. The low-pressure cylinder castings, however, meet on the centre line of the engine, where they are securely bolted together. These cylinders are placed on an inclination of 1 in 39. Owing to their large size (41 in. diameter) and the comparatively small diameter of the coupled wheels, the clearance under them would be too limited for conditions on this road if they were placed horizontally.

An automatic starting valve is used, and it is placed in a pipe which connects one of the high-pressure steam pipes with the receiver pipe. When the throttle is first opened live steam passes direct to the receiver pipe and thence to the low-pressure cylinders; but as the pressure in the receiver pipe increases, due to the high-pressure exhaust, the valve closes and the locomotive works compound.

The articulated connection between the front and rear frames is designed to give an unusual degree of flexibility. Not only is the hinge pin fitted into a spherical bushing, but the radius bar is pinned to the

MALLET LOCOMOTIVE FOR THE NASHVILLE, CHATTANOOGA AND ST. LOUIS RAILWAY.

CONSTRUCTED BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA, U.S.A.

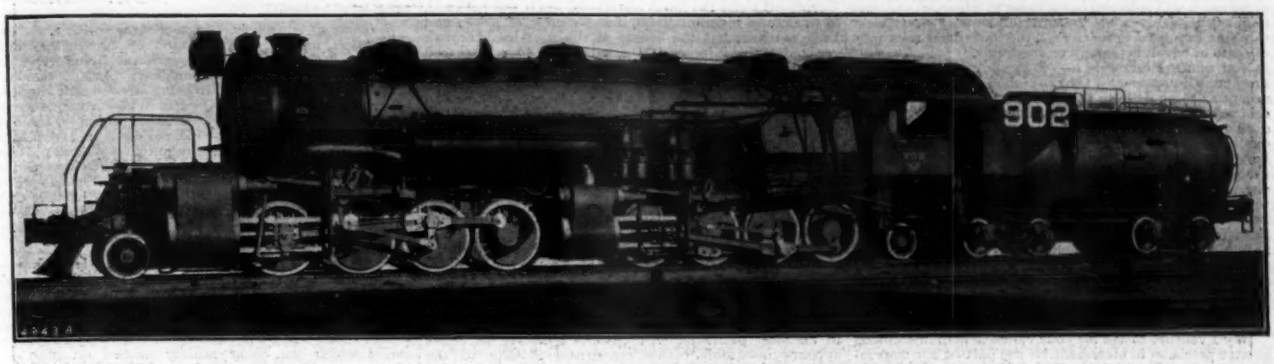


FIG. 3.

front frames in such a way as to allow relative movement between these parts in a vertical plane. The front and rear frames are neither interlocked or connected by hanger bolts. The weight, however, is evenly distributed, as there is a difference of only 1,100 pounds in the amounts carried by the two groups of coupled wheels.

The leading bogie has a swing bolster, which is hung on three point suspension links. This bogie is equalized, by means of a central beam, with the first and second pairs of coupled wheels in the forward group; while the third and fourth pairs are independently equalized. In the case of the rear group of wheels there is a continuous equalization system on each side of the locomotive.

The engine for the Nashville, Chattanooga and St. Louis Railway, shown by Fig. 3 annexed, is one of three which were specially designed for pushing service on 2 per cent. grades. Formerly, two assisting locomotives were required to move a full tonnage train over these grades. Each Mallet engine replaces two pushers, as it develops a tractive force of 99,000 pounds, which is twice that of the Mikado (2-8-2) type locomotives used on this road. The requirements in this case, therefore, were very clearly defined.

The Mallets traverse curves of 339 ft. radius, and are handled on turn-tables 90 ft. in length. In order to support the weight required for adhesion without carrying an excessive load per axle, four pairs of wheels are coupled in each group; and a two-wheeled radial bogie is used at each end, so that the locomotive tracks well when running in either direction. The wheel arrangement is thus 2-8-8-2. The front bogie is centre-bearing and the rear bogie side-bearing, and each is equalized with the adjacent group of coupled wheels. This is a flexible arrangement of equalizing rigging, which approximates, as closely as possible, a three-point suspension system.

The boiler is built with a conical connection in the barrel, which increases the shell diameter from 7 ft. 4 in. at the first ring to 8 ft. 4 in. at the throat. The furnace has a combustion chamber extending forward a distance of 4 ft. 10 in. into the boiler barrel. The use of the conical connection provides not only ample steam space above the furnace, but also a fairly deep water space under the combustion chamber. Circulation in this water space is increased by four water tubes, which extend from the bottom of the combustion chamber to the back of the fire-box. These tubes support the brick arch and add valuable heating surface.

The Standard Stoker is used on these locomotives. The fuel is conveyed mechanically from the tender to the furnace, and is blown, by means of steam jets, from a firing-table placed inside the fire-box, under the fire-door. The steam nozzles are so arranged that the coal can be scattered in any part of the fire-box. A mechanical stoker is practically indispensable in a coal-burning locomotive as large as this one.

The superheater is of the Schmidt type; and as the header is located in the smoke-box, it is necessary to convey the superheated steam to the high pressure cylinders through horizontal pipes, which are external to the boiler and are heavily lagged to prevent radiation. The high-pressure exhaust is conveyed forward to the low-pressure cylinders through a single flexible pipe, placed on the centre line of the locomotive between the frames of the front engine. This pipe has a ball joint at its rear end. The joint is seated in a suitable cavity, formed in the high-pressure cylinder saddle casting.

Name of Railway	Baltimore and Ohio Railroad.	Nashville, Chattanooga and St. Louis Railway.
Gauge	4 ft. 8½ in.	4 ft. 8½ in.
Diameters of cylinders	27 and 41 in.	26 and 41 in.
Stroke	30 in.	30 in.
Valves, high-pressure	Piston 14 in. diam.	Piston 15 in. diam.
„ low-pressure	Balanced slide	
Boiler—		
Barrel	Conical	Conical
„ diameter of largest ring	90 in.	88 in.
„ thickness of sheets	½, 1, 1 1/16 in.	½, 11/16, 1 in.
Working pressure in lb. per sq. in.	210	210
Fuel used	Soft coal	Soft coal
Form of staying	Radial	Radial
Fire-box: material	Steel	Steel
„ length	132½ in.	126 in.
„ width	96 in.	97½ in.
„ depth, front	89½ in.	83 in.
„ „ back	67 in.	68 in.
Thickness of sheets: sides	½ in.	½ in.
„ „ back	½ in.	½ in.
„ „ crown	½ in.	½ in.
„ „ tube	½ in.	½ in.
Water spaces: front	6 in.	5 in.
„ sides	6 in. to 4 in.	5 in.
„ back	4 in.	5 in.
Tubes: diameter	5½ and 2¼ in.	5½ and 2¼ in.
„ material	Steel	Steel
„ thickness	5½ in., No. 9 W.G. / 2¼ in., 0.125 in.	5½ in., No. 9 W.G. / 2¼ in., No. 11 W.G.
„ length	24 ft.	24 ft.
„ number	48, 5½ in. diam. / 260, 2¼ in. diam.	43, 5½ in. diam. / 253, 2¼ in. diam.
Heating Surface and Grate Surface—		
Fire-box	228 sq. ft.	228 sq. ft.
Combustion chamber	113 „	116 „
Tubes	5,443 „	5,044 „
„ carrying firebrick arch	52 „	45 „
Total	5,836 „	5,433 „
Superheater	1,415 „	1,262 „
Grate area	88.2 „	85.5 „
Wheels—		
Driving wheels: diameter, outside	58 in.	56 in.
Driving wheels: diameter, centre	50 in.	50 in.
Driving axles; main journals	10½ × 16 in.	11 × 12 in.
Driving axles; other journals	10 × 13 in.	9½ × 12 in.
Truck wheels: diameter	33 in.	33 in.
„ axles, journals	6 × 10 in.	5½ × 12 in.
Wheel base—		
Driving	41 ft. 2 in.	40 ft. 4 in.
Rigid	15 ft. 6 in.	15 ft. 0 in.
Total engine	50 ft. 4 in.	55 ft. 8 in.
„ engine and tender	87 ft. 5½ in.	85 ft. 7⅞ in.
Weight—		
On driving wheels	462,500 lb.	430,300 lb.
„ truck, front	23,100 lb.	20,100 lb.
„ „ back	—	19,000 lb.
Total engine	485,600 lb.	469,400 lb.
„ engine and tender	692,000 lb.	About 655,000 lb.
Tender—		
Wheels, number	Eight	Eight
„ diameter	33 in.	36 in.
Axle journals	6 × 11 in.	5½ × 10 in.
Tank capacity	12,000 U.S. gals. (= 9,600 English gals.)	8,500 U.S. gals. (= 6,800 English gals.)
Fuel capacity	20 tons	14 tons

The steam distribution to all the cylinders is controlled by inside admission piston valves. These are 15 in. in diameter and are operated by the Walschaert's valve gear. The gears are so designed that, when running forward, the link blocks of the high-pressure engine are below the link centres, and those of the low-pressure engine above the link centres. The radius rods thus balance one another when reversing or changing the cut-off.

A simple arrangement, patented by the builders, is used for connecting the lift shafts of the front and rear engines. This device consists of a single reach rod, which is placed on the centre line of the locomotive and is provided with a flexible joint. The joint is guided between the inner walls of the high-pressure cylinder saddle, and is located immediately above the articulated frame connection. With this construction there is a minimum tendency to distort the movement of the low-pressure valves when the locomotive is traversing curves.

The front and rear frames are connected by a cast steel radius bar. This bar is rigidly bolted to the front frames, and is fitted at its rear end with a spherical bushing of case-hardened wrought iron. The bushing is bored out to receive the hinge-pin, and it can turn in the radius bar. With this construction there can be no binding action between the pin and the radius bar, should the front and rear frames have relative motion in a vertical plane.

The forward extension of the boiler, over the front frames, is supported by two bearers. The wear is taken, in each case, by a renewable brass shoe. The front bearer is fitted with controlling springs, for the purpose of restoring the alignment of the frames after traversing curves.

Live steam can be admitted to the low-pressure cylinders through a pipe which is tapped into the receiver pipe and is connected to a lever valve conveniently placed in the cab. This valve is opened only in starting. As soon as the low-pressure cylinders are receiving the high-pressure exhaust the valve is closed, and the locomotive works compound entirely.

Both the locomotives illustrated are shown equipped with Vanderbilt tenders. In the case of the Nashville engines these tenders have been exchanged for others with rectangular tanks which were formerly used with passenger locomotives. The Vanderbilt tender, with its cylindrical tank, has easily accessible running gear and is readily inspected; and it is in extensive use on a number of American roads.

The accompanying tabular statement contains the principal dimensions of the locomotives described above.

SULPHITE RESIDUE AS FUEL.—Much interest attaches to the invention by Mr. R. W. Strehlenert, a Swedish engineer, of sulphite coal from the residue of sulphite wood pulp. A company has been formed in Norway for the exploitation of the invention, with a capital of 90,000*l.*, and the large Union Company, the Greaker Cellulose Company, and the Norwegian Company for Electro-Chemical Industry, are stated to be interested in the new concern. The residue from sulphite manufacture is large, as the paper pulp only accounts for about 45 per cent. of the original weight of the wood. The balance has so far been neglected, with the exception of that portion employed in the sulphite spirit manufacture. In this only 1½ per cent. is utilised, so that more than 50 per cent. of the total weight of the wood remains unused. In the Strehlenert process the product is a coal or coal powder, of a heating value of 12,400 B.Th.U. per lb. It is calculated that the production of cellulose in Sweden and Norway amounts in the aggregate to about 1,000,000 tons per annum, of which about three-fourths comes from Sweden and one-fourth from Norway. The first works are being commenced at Greaker, between Sargsborg and Frederikstad, with an initial capacity of some 6,000 tons annually, the quantity of coal which the Greaker Cellulose Works use in the year.

THE PRINCIPLE OF RELATIVITY.

To the Editor of Engineering.

Sir,—On pages 132–134 of your issue of the 11th inst. there appeared an interesting article under this heading; and, although "that expression has assumed a definite meaning," I submit that a vast amount of nonsense is still indulged in by those to whom an engineer might reasonably wish to turn for help towards clear thinking in regard to matters, "the immediate relevancy of some of which he hardly understands."

You quote Minkowski:—"But all our observations are bound to space and time. Nobody ever saw a place except at some definite time, nobody ever noticed a time except at some place." Well, how can we ever expect ordinary folk to be anything but muddle-headed when one of our great teachers is so slack in his expressions? How can anyone "notice *a time*?" The notion of time (duration) first arose in human creatures when our remote ancestors became brainy enough to notice that objects moved—for without motion we could have no idea of time; but there is no such thing as *motion* or *time*, for the simple but sufficient reason that they are not *things*! Motion is merely the condition of a body which is changing its position relatively to other bodies; and we cannot put motion into a body, though we may set a body in motion; yet some of our philosophers often talk as if we could do so, and thus lead to their own and our undoing.

May I venture to ask for your valuable help in securing greater precision in statement on the part of our instructors who, by mistaking words for things, do not deliver us "from those fallacies which we are apt to put upon ourselves," as Locke warned his readers more than 200 years ago.

August 21, 1916. Sesamy.

HOW SHALL WE PROMOTE INDUSTRIAL PROGRESS?

To the Editor of Engineering.

Sir,—The letter of Mr. Neil J. Maclean, of Glasgow, published in your issue of the 18th inst., opens out an important subject as affecting the engineering and allied trades—*i.e.*, the forming of permanent exhibitions in the large cities throughout the United Kingdom. The existence of such would foster industry and supply a long-felt want. The details of a scheme would be too lengthy to enter into here and take up too much of your valuable space.

The reason why I write you hereon is because in the pre-war days I advocated some such scheme, for the purpose of exhibiting the models of inventors. In the present suggestion inventions could be incorporated, in which the members of the exhibition could be given preferences as to licences and purchases of inventions.

By this means the local industries around large centres could exhibit the present manufactures with the ever-increasing new products, the outcome of inventive brains—to which latter great encouragement has been given at all times by Germany. Again, these repositories of industrial property would and could be utilised by our present Allies and neutral nations, thus affording not only a means of intercommunication for the home industries but an international source.

There is no reason why the present proposals should not prove a great and successful financial undertaking where buyers and sellers could be brought together, inventors encouraged, and statistical information recorded and kept of our international trade. Without encroaching further on your valuable space, I conclude by offering my services in the matter, as one with long experience in inventions, patents, and allied matters, and would be glad to hear from any of your readers hereon, with a view to carry this into a concrete form, as now is the opportune time to capture much of the world's trade.

I may add that I am now connected with an Association having for its object British and Russian trading.

J. H. Butterworth.

6, St. Mary's Gate, Manchester, August 22, 1916.

DRAUGHTSMEN.

To the Editor of Engineering.

Sir,—And so we are to have Trades Unionism in the drawing office, and, presumably, the limitation of output, equal pay for efficiency and non-efficiency, and all those methods by which the Trades Unions have done their best to ruin England and may yet succeed in doing so. Where we shall get to remains to be seen, but we have already descended so low that your columns can be used to inform draughtsmen who have stayed at home that in a time of the gravest national danger and distress they can claim time and a-quarter for not taking holiday when so many of their comrades and compatriots have given up everything, and are risking and losing their lives in the service of their country. Some of the workmen have felt insulted by this time and a-quarter, and are refusing to soil their hands with it, but apparently the Association of Engineering and Shipbuilding Draughtsmen is out for all it can get. My experience is that the average draughtsman is a thoroughly good sort, and as patriotic as any, but what the "Association" will succeed in making of him is another matter.

Yours truly,

Chief Draughtsman.

More Northern Coal.—In the neighbourhood of Wear Valley Junction—the entrance to Weardale—preliminary operations are in progress for a drift into a virgin royalty of coal acquired by Messrs. Stobart. The seam which is to be attacked is reported to be 6 ft. thick and runs near Witton Castle, Witton-le-Wear.

NOTES FROM THE UNITED STATES.

Philadelphia, August 9.

An advance of 2 dols. a ton has been made on wire and wire products. Bars and shell steel have also been advanced, as well as Bessemer billets. Indications point to the starting in a very short time of heavy buying all along the line; some time ago it was believed, even among manufacturers, that the crest of prices had been reached, but the events of the past week or two contradict this inference. Implement steel has advanced again, and large orders are dropping in. Very large orders for munitions have been placed within the past ten days. Structural shapes are slow but steel plates cannot be had as fast as wanted. A new enterprise in Virginia has just called for 17,000 tons of plates. Atlantic shipyards have offered Pittsburgh mills orders aggregating 50,000 tons of plates. A further advance of plates seems unavoidable because of heavy incoming orders for car construction. A Seattle, Washington, shipyard, some 3,500 miles from the Eastern Atlantic coast, wants 12,500 tons of plates for four boats. The Steel Corporation has booked orders for 45,000 tons of rails, and the total orders for July are estimated at 450,000 tons, including the immense Russian order. Exporters of tin-plate are trying to place orders at 7 dols. a box. An inquiry appeared at Pittsburg during the week for 100,000 tons of basic; a Portsmouth, Ohio, concern closed for 30,000 tons basic; the outlook is for continued activity in all steel products. An upward tendency in prices appears inevitable. New enterprises looking to the increased production of steel are heard of, and blast-furnace capacity will be soon expanded; the new furnaces are being built to supply large interests with their own crude iron. Export trade is assuming extraordinary proportions. The plate mills are in no position to take on more than a small part of the business offered. Steel-making grades of pig will be very soon in demand beyond any reasonable prospect of delivery; production must increase, and prices will advance regardless of conditions on this side.

Victorian Hardwoods.—The question of utilising Victorian hardwood more extensively in public buildings of the Colony without causing a large increase in expenditure has been under consideration by the Minister for Public Works (Mr. Adamson) for some time past. Mr. Adamson stated that he was so satisfied with the suitableness and cost of the timber that he had issued directions to his department for a more extensive use of Victorian hardwood weatherboards and linings for new public buildings, and for extensions of existing buildings, where practicable. Internal finishings of plain design were to be of the same material, and it was anticipated that, with the simple method of oiling the surface lightly, or leaving the natural wood finish, the ultimate cost would be less than if the work were done with imported soft wood. Directions had also been issued that school fittings and office furniture and fittings for the public departments were to be constructed of Victorian hardwood, and experiments were being made to ascertain whether Victorian hardwood could be used in school furniture at a cost which would compare favourably with Queensland hoop pine, which had been used largely for some years. Every effort would be made to introduce to the fullest extent Victorian hardwood in the new University buildings, for which working designs were now being prepared. An arrangement had been made with the Government seasoning kiln at Newport to supply seasoned hardwood weatherboards for Government works at the rate of 11*s.* 9*d.* per 100 ft. lineal, and if the output of the mill compared reasonably with samples submitted, a distinct saving would be effected.

Submarine Telegraph Property.—The Submarine Cables Trust was an interesting financial experiment in purchasing for investment a mass of shares in submarine telegraph companies. The object was to pay a steady annual interest of 6 per cent. upon the capital raised and carry any surplus forward to be dealt with later on at the discretion of the investors in the undertaking. The revenue of the Trust has considerably exceeded the annual interest paid and the certificates outstanding have been reduced accordingly, from 420,000*l.* to 263,300*l.* The total number of 100*l.* certificates redeemed has been 1,567; of these, 819 were surrendered with all coupons, but the remaining 748 have been disposed of exclusive of coupons of reversion. The total surplus revenue available for the redemption of certificates for 1915–16 was 8,109*l.*, and as the surplus revenue steadily increases with the redemption of certificates out of income there is a probability of the coupons of reversion having at last a considerable value. The net return last year upon the company's nine investments was as follows:—American Telegraph and Cable Company shares, 4*l.* 18*s.* 7*d.* per cent.; Anglo-American Telegraph Company preferred stock, 8*l.* 0*s.* 6*d.* per cent.; Central and South American Telegraph Company shares, 8*l.* 1*s.* 7*d.* per cent.; Eastern Telegraph Company ordinary stock, 9*l.* 2*s.* 10*d.* per cent.; Eastern Extension, Australasia and China Telegraph Company 10*l.* shares, 9*l.* 18*s.* 3*d.* per cent.; Great Northern Telegraph Company 10*l.* shares, 6*l.* 2*s.* 4*d.* per cent.; Mackay Telegraph Companies 4 per cent. preferred shares and common stock, 8*l.* 6*s.* 2*d.* per cent.; Western Telegraph Company, 10*l.* shares, 5*l.* 0*s.* 2*d.* per cent.; and West India and Panama Telegraph Company 10*l.* ordinary shares, 1*l.* 2*s.* 2*d.* per cent. The Trust has been skilfully managed throughout, but its success has been largely, if not wholly, due to early purchases made by it of shares and stock in the Anglo-American, Eastern, and Eastern Extension Telegraph Companies when such shares and stock were obtainable at much lower prices than those which were subsequently reached.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Glasgow Pig-Iron Market.—The lifeless conditions of the pig-iron warrant market remain unchanged, nor does there seem any immediate prospect of a resumption of active business. Stocks in store are practically on the same level as last.

Sulphate of Ammonia.—In accordance with a recommendation made by the Board of Agriculture and Fisheries, some considerable attention is being given to sulphate of ammonia as a fertiliser. At the moment farmers and agriculturists are being advised that supplies are now available and may be had in required quantities from the present time onwards until, probably, the end of September, at the rate of 15*s.* per cwt. It is expected that at this reduced figure the requirements of all possible customers will be satisfactorily met. Following this the price will advance 6*d.* per cwt. net cash. Although it is too long to look forward, there is just a chance that sulphate of ammonia may be very much scarcer later on, in consequence of the heavy demands of the Ministry of Munitions.

Scotch Steel Trade.—While there is little difference in the conditions of activity in any of the local steel-producing establishments, these continue highly satisfactory, and it is expected that, if there be a sufficiency of labour available, a very considerably increased output should result when the various extensions and improvements which are being rapidly pushed on with are completed. The high pressure of the past year has rendered repairs and alterations to plant and machinery absolutely essential—the continued and increasing demand for war material of all descriptions has suggested extension wherever this is practicable, and manufacturers are doing all in their power to meet the requirements of our own and the Allies' Governments. In consequence there is no slacking-off in the general industrial activity. Shells and munitions have first call, and the demand is insatiable, recent pronouncements having demonstrated clearly how very important it is that the supply of shells, guns, &c., should be well maintained. Raw material continues to become scarcer, and the labour problem more difficult, so that prices, while keeping steady, may ultimately stiffen. Meantime they are much on the level of last week—ship-plates, 15*l.* per ton; boiler-plates, 16*l.*; and angles, 14*l.* 2*s.* 6*d.* and upwards.

Malleable-Iron Trade.—Makers of malleable-iron have so much of their time and attention taken up in supplying the requirements of the naval and military forces that they have less opportunity than ever of considering the needs of their ordinary mercantile customers. Nor is there the slightest chance of any change during the continuance of the war. "Crown" bars keep steady at 14*l.* 12*s.* 6*d.* per ton, less 5 per cent., for home delivery; and export, 14*l.* 2*s.* 6*d.* f.o.b. Glasgow.

Scotch Pig-Iron Trade.—The demand for Scotch pig-iron of all grades is unabated, practically the entire output being consumed locally. With so many of the works—not engaged directly on contracts for munitions—being on holiday this week, there is just a chance that the demand may ease off slightly for a day or two. Otherwise the conditions are very much as they were a week ago, few licences being granted except in the case of supplies for the Allies. Both hematite and foundry iron are scarce, as much of the latter as possible being earmarked for home consumption. There is no change in prices.

New Steel-Works.—It has just been announced that the Scottish Iron and Steel Company has acquired a site for a new steel-works which they purpose erecting in the immediate vicinity of the Waverley Works, Coatbridge. The estimated cost of the erection of the new establishment is given as between 4,000*l.* and 5,000*l.*, and it is expected that about 500 hands will be employed.

Japanese Metallurgy.—Negotiations have been completed by which the Sino-Japanese Industrial Development Company has acquired the right of working the Taochung iron mine at Taochang, China. The mine is estimated to contain 60,000,000 tons of ore, assaying at 65 per cent. The Japanese steamer Tatsuno Maru, which recently left Seattle, carried 5,000 tons of steel plates, angles and bars consigned to Japanese shipbuilding yards.

Russian Railways.—The earnings of Russian railways in 1915 amounted to 1,555,223,507 roubles, showing an increase of 85,627,685 roubles as compared with 1914. The earnings of the Government lines alone amounted to 790,238,566 roubles. The number of passengers carried last year was 227,296,427, as compared with 241,073,661 in 1914. The quantity of freight carried last year was 13,376,315 poods, or about 500,000 poods less than in 1914.

Electrically-Driven Hoppers for Coke Ovens.—To charge coke ovens with coal electrically is not a novelty. The first appliances of this kind were, however, only suitable for new oven plants, the cars weighing empty 10 tons, and full more than 20 tons, so that strong foundations were wanted for the tracks. The colliery Constantin, near Bochum, has recently (*Glück Auf*, volume 51, pages 989 to 991) introduced a smaller type of hopper-cars, which can be adapted to old coke-oven plants of less strong construction. These cars have a length of 4,000 mm., a width of 1,200 mm., and a height of 1,700 mm., and contain about 3 tons of coal. They are driven by continuous-current electric motors of about 4 kw. Trains of three cars are sent from the coal tower to the coke oven.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

South Yorkshire Coal Trade.—The new regulations with regard to the importation of coal into France are being severely criticised in this area. An involved process of securing the necessary permits produces vexatious delays and considerable irritation. Collieries and merchants have to obtain licenses from Paris, have them endorsed in London, and then secure the permission of the Local Coal Distribution Committee before they can take any actual steps to forward consignments. The results will lead to a dislocation of much of the cross-channel coal traffic, for depleted colliery clerical staffs are already overburdened. With regard to the measures to be taken to increase the coal supply to Italy, collieries have already received informal notice of the steps proposed, and the matter will doubtless be arranged amicably and expeditiously. At present there are ample supplies of all classes of fuel on the market, but any augmenting of the export trade will tighten the position. Best qualities of house coal are being freely bought for stocking purposes, but the country trade has now fallen off with the advent of the harvest-time. Inferior sorts find their way to gas companies in large quantities. Railway companies and munition works are taking the full output of best steams and hards, and are laying up considerable winter stocks. Cobbles and nuts remain active. The position of slacks has improved during the last few days, and buying is on a heavier scale. Cokes are still firm, and at full values. Quotations:—Best branch hand-picked, 20*s.* 6*d.* to 21*s.* 6*d.*; Barnsley best silkstone, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire best brights, 17*s.* 6*d.* to 18*s.* 6*d.*; Derbyshire house, 16*s.* to 17*s.*; best large nuts, 15*s.* 6*d.* to 16*s.* 5*d.*; small nuts, 15*s.* to 16*s.*; Yorkshire hards, 16*s.* to 17*s.* 6*d.*; Derbyshire hards, 16*s.* to 17*s.*; best slacks, 12*s.* to 13*s.*; seconds, 10*s.* 6*d.* to 11*s.* 6*d.*; smalls, 8*s.* to 9*s.* per ton.

Iron and Steel.—The change of the official maxima of prices seems to have rudely disturbed the settled condition of the market which the original scheme produced. Variations in quotations are again the order of the day, and the fluctuating state of the market cannot be viewed with satisfaction by either the makers or consumers. Pig-iron is not being extensively purchased. Foundry iron is only meeting a very moderate inquiry, and both Lincolnshire and Derbyshire manufacturers find it a matter of the utmost difficulty to do business at the top figure. Much of the Derbyshire quality has recently changed hands at a concession of 2*s.* 6*d.* Forge is in slightly better demand, but not nearly so great as to tax the resources of the producers. For hematites there is always an inquiry for full supplies, especially of the better brands. Short deliveries of tungsten tend to interfere with the output of high-speed twist drills, which are wanted in enormous quantities. High-speed steel manufacture is at present in full swing, for the installation of electric furnaces has had the dual effect of enlarging and cheapening the production. Sheffield manufacturers seem completely won over to the electric furnaces for the production of a variety of steels, and there are additional installations at regular intervals. Indeed, Sheffield was never so well equipped with electric adjuncts to the engineering industry as she is to-day. Several interesting trade departures have been made. A large firm has arranged for the building of half a dozen 50-ton basic steel furnaces, which will result in a considerable accession to the city's output of steel. One of the objects sought is to render Sheffield less dependent than ever upon the German cheaper grades of steel. The Renishaw blast-furnaces are to be restarted. They consist of three furnaces and a foundry, and have been acquired by a syndicate which intends to turn out forge and foundry iron, as was done by the former owners. Tramway business is brisk. There are some good contracts placed for crossings and points. The Sheffield Corporation have ordered 15 "Peckham" trucks. Wheels of a special construction for traction engines and motor cars which have to traverse uneven roads and marshy ground are being manufactured by several firms. The Government has ordered choppers, portable steam engines, water-tank trailers, wheelbarrows, clasp knives, razors, butchers' steels, and tools. The cutlery trade is suffering from a lack of skilled labour and a pressure of orders. Many manufacturers are in danger of being penalised for arrears on War Office and Admiralty contracts. Cutlery making for the domestic trade is rapidly coming to a standstill. From overseas comes an unusually varied list of orders, including those for tools, augers, saws, sheep shears, machine irons, sickles, files, machetes, cutlery, wheels, axles, hardware and steel. New avenues of business have been established with foreign and colonial commerial houses.

RUSSIAN GOVERNMENT UNDERTAKINGS.—The Russian Government is stated to have somewhat reluctantly decided upon opening up the petroleum fields, not yet let, in the Old-Baku district as a State enterprise. An attempt to let these fields in the open market did not lead to any acceptable bid, and the Minister of the Interior declined to accept the offers of the syndicate companies. A naphtha inspection board is to be formed to control the working of the concerns which have rented State petroleum fields. This new departure of the Russian Government is likely to be followed by other Crown undertakings, so as to make the Government more independent of private enterprise. Among other new projects there may be mentioned the erection of large iron works for the manufacture of railway material, and a rolling mill for rails has also been under contemplation. A second project, also emanating from the Traffic Ministry, refers to the acquisition of coal mines for State purposes.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Demand for Cleveland pig-iron continues good, and thanks to the careful action of the Distributing Committee deliveries are regularly maintained and all essential requirements are met, but an increase of production would be very welcome. It is therefore very gratifying to learn that preparations are proceeding for the re-starting of two additional furnaces to manufacture Cleveland pig, and hope is entertained that they will be in operation within the next few weeks. Inquiries are numerous, and a fair amount of business is passing. Several sales of Cleveland pig to Scotland, for delivery next month, are reported. For home consumption, No. 3 Cleveland pig, No. 4 foundry and No. 4 forge all stand at 87*s.* 6*d.*; whilst No. 1 is put at 91*s.* For export, No. 3 is 97*s.* 6*d.*; No. 4 foundry, 95*s.* 6*d.*; No. 4 forge, 95*s.* 6*d.*; and No. 1, round about 102*s.* 6*d.*

Stocks of Cleveland Pig-Iron.—Practically the only stock of Cleveland pig-iron in existence is that held in the public warrant stores here, and it is gradually disappearing. In 1906 the stock in the warrant stores stood at 750,000 tons. To-day the quantity held is 17,681 tons, composed of 17,295 tons of No. 3 quality, and 386 tons of other descriptions of iron deliverable as standard. Since the beginning of the month the stock has been reduced by 6,119 tons, 6,135 tons of No. 3 having been withdrawn, and 16 tons of standard iron having been added.

Hematite Iron.—As regards East Coast hematite iron, new business is very difficult to arrange. There is hardly any free iron available for disposal, merchants having command of practically none, and most makers having sold their output well ahead. Care is taken regularly to supply essential quantities to home consumers, and exports to our Allies are allocated according to urgency of needs. For home use, and for shipment to France, Nos. 1, 2 and 3 still stand at 122*s.* 6*d.*, and for general export 140*s.* and upward is quoted.

Coke.—Demand for coke for local consumption is good, but supply is rather more than adequate. Quotations are unaltered. Average blast-furnace kinds stand at 28*s.* at the ovens, and up to 30*s.* 6*d.* at the ovens is still asked for qualities low in phosphorus.

Foreign Ore.—Values of foreign ore are upheld, notwithstanding the large and still steadily increasing stocks. Imports on running contracts are very heavy, the unloadings at the port of Middlesbrough to date this month reaching 173,164 tons. Consumers are not in the market to buy, and consequently business is almost at a standstill, but sellers show no disposition to reduce quotations. On the basis of the official 17*s.* freight, Bilbao-Middlesbrough, Rubio of 50 per cent. quality was 38*s.* ex-ship Tees.

Manufactured Iron and Steel.—Producers of finished iron and steel continue very busily employed on Government work, and have little time to attend to ordinary private inquiries. Prices are very firm. Common iron bars are 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship-plates, 13*l.* 10*s.* to 14*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; iron ship rivets, 17*l.* 10*s.* to 18*l.* 10*s.*, according to diameter; packing iron and steel (parallel), 10*l.*; packing iron and steel (tapered), 12*l.* 5*s.*; steel bars (no test), 14*l.* 10*s.*; steel ship-plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel ship rivets, 20*l.*; steel hoops, 16*l.* 10*s.*; steel strip, 17*l.*; steel joists, 11*l.* 2*s.* 6*d.*; heavy steel rails, 10*l.* 17*s.* 6*d.*; and steel railway sleepers, 12*l.*

Shipments of Iron and Steel.—Shipments from the Tees are up to expectation. So far this month those of pig-iron amount to 36,746 tons, as compared with 39,710 tons to the same date last month, and 20,528 tons for the corresponding part of August last year. Clearances of manufactured iron to date this month are officially returned at only 1,348 tons, and loadings of steel at 6,178 tons.

Shipyard Holidays.—Arrangements have been made whereby shipyard workers on the North-East Coast are to be given a week's holiday, commencing September 2, in place of the postponed week's holiday. In the case of men required on urgent Government work and necessary repairs a week's holiday is to be given later.

THE DAIMLER COMPANY.—On page 160 of our last issue we referred to the acquisition of land by the Daimler Company to extend their works in Germany. The company referred to was, of course, the Daimler Motorien Gesellschaft and not the Daimler Company, Limited, of Coventry, which is a British firm and has no connection with the German firm in question.

AMERICAN FIELD ARTILLERY.—The Committee of the United States Senate on military affairs, being much impressed by the course of the European war, has made a large increase in the field artillery available for arming the National Guard, and with this object it has increased an appropriation of 8,000,000 dols. made by the House of Representatives to 14,000,000 dols. The Senate also raised the amount available for the purchase of field guns from private manufacturers from 4,000,000 dols. to 11,200,000 dols. The appropriation made by the House of Representatives for ammunition for field artillery for the National Guard was also increased from 8,000,000 dols. to 14,000,000 dols.; and the amount available for the purchase of ammunition from private manufacturers was carried from 4,000,000 dols. to 8,000,000 dols.

NOTES FROM THE SOUTH-WEST.

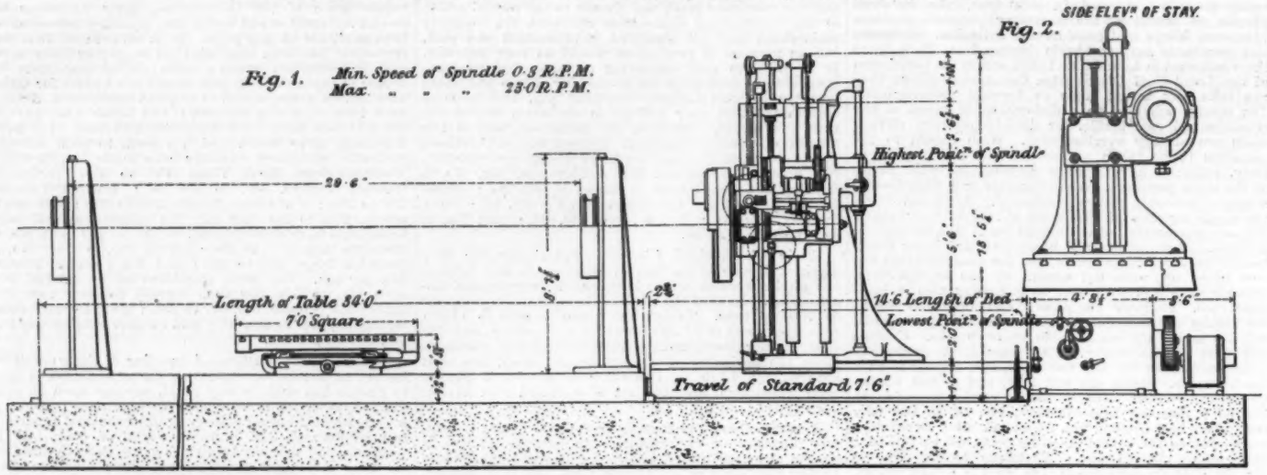
Cardiff.—Tonnage having arrived upon a substantial scale, exporters have shown anxiety to make deliveries; but as colliery owners have had first to meet considerable requirements of the Government, only oddments of second Admiralties and better class Monmouthshires have been available at any price. It is announced that an agreement has been concluded for supplying Italy with coal at limitation prices; some official statement of details is expected daily and meanwhile buyers for Italy have shown a disposition to suspend operations. Smalls have been in strong demand; and house coal, patent fuel and coke have continued scarce and dear. The best Admiralty large steam coal has been, to some extent, nominal; secondary qualities have made 38*s.* to 41*s.*; Monmouthshire Black Veins, 40*s.* to 41*s.*; ordinary Western Valleys, 40*s.* to 40*s.* 6*d.*; Eastern Valleys, 37*s.* to 38*s.*; best bunker smalls, 29*s.* to 30*s.*; and cargo smalls, 20*s.* to 24*s.* per ton. In bituminous coal best households have made 25*s.* 6*d.* to 26*s.* 6*d.* per ton; No. 3 Rhondda large, 37*s.* to 38*s.*; smalls, 29*s.* to 31*s.*; No. 2 Rhondda large, 33*s.* to 35*s.*; and No. 2 smalls, 23*s.* to 24*s.* per ton. The latest quotation for patent fuel has been 45*s.* to 50*s.* per ton. Special foundry coke for export has brought 62*s.* 6*d.* to 65*s.*; good foundry coke for export, 60*s.* to 62*s.* 6*d.*; and furnace coke for export, 50*s.* to 55*s.* per ton.

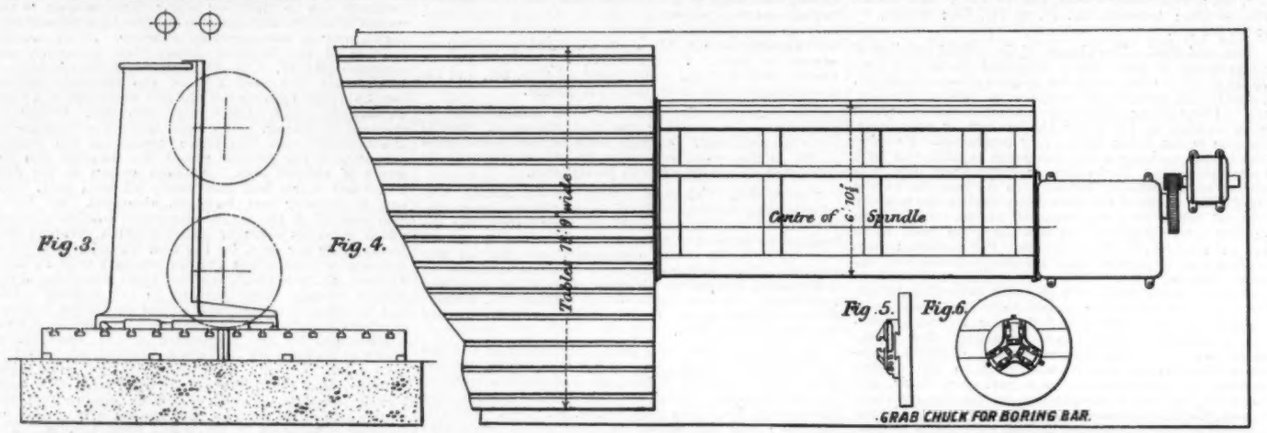
Western Trade Matters.—A meeting of the committee formed at Cardiff for regulating the exportation of coal to France has made a levy of ½*d.* per ton upon all coal shipped under the limitation of prices scheme; the levy is to be divided among colliery proprietors, coal exporters and shipowners, and it takes effect as from July 1. Authorisation will not be given by the Paris Committee for sales for longer periods than three months; but contracts can be made for longer times, subject to the control of the Paris Committee and the local committee; vessels may be taken on time charters. At the annual meeting of the Windsor Steam Coal Company, the chairman (Mr. W. T. North Lewis) said the question of absenteeism was very serious, the company having lost 7,811 shifts during the last five weeks out of a total number of about 1,800 men employed. Owing to shortage of labour, this output showed a decrease of about 22,000 tons this year; comparing the present output with the pre-war period, the decrease was upwards of 100,000 tons. Dividend arrears on the first preference shares had now nearly all been paid. The cost of working was, however, abnormal. Mr. Lewis also presided at the annual meeting of Insoles, Limited, which gives its ordinary shareholders a dividend and bonus of 20 per cent. for the past financial year. The licensing scheme which the Government took in hand resulted, Mr. Lewis said, in a very large proportion of the world's tonnage being brought to this country; this had the effect of considerably easing the current position of affairs, and the market was now on a more level keel. Negotiations for the acquisition of the Mannesmann works at Swansea by Baldwin's, Limited, are stated to have fallen through; it is considered not improbable, however, that the works will be transferred to a large Scotch company. Warrants for an interim dividend at the rate of 20 per cent. per annum were posted on Tuesday evening by D. Davis and Sons, Limited. The Committee of the Cardiff Stock Exchange has sanctioned dealings in the new 1*l.* ordinary shares of the Ebbw Vale Steel, Iron and Coal Company, Limited. The directors of the Burry Port and Gwendreath Valley Railway Company recommend interim dividends for the past half-year at the rate of 5 per cent. per annum upon the preference shares and 6 per cent. per annum upon the ordinary shares, carrying forward 3,812*l.* For 48 years the Public Works Loan Board have been mortgagees in possession of Falmouth Docks; the dock company has now, however, repaid all the advances (87,250*l.*) with interest. The directors of the Main Colliery Company, Limited, have decided to make a distribution on account of profits without waiting for the completion of the year's accounts; the interim dividend upon the fully-paid ordinary shares is to be 24*s.* per share, less income-tax; the participating preference shares will receive 36*s.* per share. Freight rates for the Mediterranean were generally easy at Cardiff on Saturday owing to the fact that while a considerable amount of tonnage was offering, there were few inquiries for prompt loading in consequence of the difficulty experienced in obtaining supplies of coal. A Swansea coal prices sub-committee, presided over by the mayor, has decided to accede to a request of the local coal owners to allow an increase in the price of domestic coal; the association asked for an advance of 1*s.* per ton and has been allowed 6*d.* per ton. The price of the best coal will be about 36*s.* 9*d.* per ton, with 1*s.* 6*d.* per ton extra for hilly districts. On Saturday, Mr. D. T. Alexander, pursuant to an Order of Mr. Justice Astbury, offered for sale by auction the Cefn Cib mineral estate, between Pontypool and Crumlin. Mr. Alexander stated that he had been informed that there were 5,000,000 tons of workable coal in the property. The coal measures, he added, were practically intact, and being situated in an important district they were likely to be quickly developed. The bidding was started at 36,000*l.* and was carried to 41,000*l.*, at which price the Tirpeatwys Colliery Company acquired the property. The Redcroft Steam Navigation Company will pay a dividend and bonus of 20 per cent., September 1.

THE LIMMER ASPHALT PAVING COMPANY LIMITED, AND THE TRINIDAD LAKE ASPHALT PAVING COMPANY, LIMITED.—This Company will in future be carried on as one concern under the name of The Limmer and Trinidad Lake Asphalt Company, Limited, at Caxton House, Westminster.

MOTOR-DRIVEN HORIZONTAL TURBINE BORING MACHINE.

CONSTRUCTED BY MESSRS. G. AND A. HARVEY, LIMITED, ENGINEERS, GLASGOW.





We illustrate in Figs. 1 to 6 on the present page, and in Figs. 7 and 8 on Plate XVIII, a motor-driven horizontal boring machine, built by Messrs. G. and A. Harvey, Limited, Albion Works, Glasgow. The machine consists of a main bed with a work-plate bolted to one end in the same line, the work-plate being fitted with the boring bar stays. On the bed is fitted an upright slide or standard which carries a balanced saddle adjustable vertically. The driving and feed gear is placed in a cast iron box at the end of the bed.

The main bed is 14 ft. 6 in. long, 6 ft. 10½ in. broad and 18 in. deep; it is of strong section and is accurately planed on its upper surface, edges, on the end for securing the work-plate and on the outside end for taking the gear box. The standard is of strong box section and large base; it is provided with self-acting feed and, in addition, power traverse and hand adjustment in either direction. The guide for the standard on the bed is long and narrow and adjusted by a taper wedge. The standard can be locked in any position; the length of traverse on the bed is 7 ft. 6 in. The saddle is balanced and well fitted to three planed surfaces on the face of the standard; it is raised or lowered by hand or power. The saddle has a vertical travel of 5 ft. 6 in.; the centre of the spindle in the lowest position is 2 ft. 4 in., and in the highest 7 ft. 10 in. above the top of the table. The spindle is of strong cast iron and revolves in hard gunmetal bearings; the front journal is 10 in. and the back journal 5½ in. in diameter. Adjustable rings are provided at the back end of the front journal to take up wear, the front end being provided with hard gunmetal rings to take the thrust of the feed and ample surface being allowed for wear.

The spindle is driven from a 40 h.p. constant-speed motor on the box at the end of the bed, through an all-gear drive to the shaft in the bed, thence by bevel wheels and vertical shaft to a horizontal shaft in the saddle. A spur pinion keyed on the end of the horizontal shaft gears into a large spur wheel on the end of the spindle. The saddle is fitted with double gear and the gear box with six changes of gear, giving in all 12 speeds to the spindle. The latter has a maximum speed of 23 revolutions and a minimum speed of 0·3 revolutions per minute. The spindle drive is fitted with reversing gear on the saddle, so that the chuck may be revolved in either direction. The chuck is 53 in. in diameter and is made with vees for the tool slide on one side, there being a ring for an internal driving wheel cast on the back, making the chuck very rigid and free from spring. The facing slide is placed on the front of the chuck in adjustable vees and has a self-acting feed or hand-travel of 33 in. The tool holder has a large base and is made separate from the slide to permit the fixing of other tool holders of varying form. The facing tool will operate on any part of a surface from the centre of the spindle to 66 in. diameter. The slide on the face plate is broad and long, and thus is suitable for long overhung boring bars.

There are four changes of feed to the standard and tool slide, viz., 6, 10, 18 and 24 per inch, obtained from the gear in the gear box at the end of the bed. Without stopping the machine the feeds can be changed, stopped or reversed instantaneously by levers placed in convenient positions. The tool slide and standard have each a separate hand adjustment which can be operated whilst the machine is running. The standard has power traverse and, in addition, hand adjustment in either direction from the gear box at the end of the machine. Traverse and feed cannot be in gear at the same time. The rate of traverse is 4 ft. per minute.

A work-plate 34 ft. long and 13 ft. 9 in. broad, made in four pieces bolted together, with tee slots planed from the solid on its upper surface, is fixed at one end of the bed. The work-plate is provided with a table 7 ft. square and capable of being revolved by hand through worm and worm-wheel, and locked in four right-angle positions. The table is carried in a cross-slide which is bolted securely to the work-plate in any position longitudinally. The cross adjustment of the table is over 3 ft.

The wheels have all machine-cut teeth from solid blanks, and where necessary are made of cast or forged steel.

The machine has been specially designed for general work, and also particularly for the manufacture of turbine details. By means of the revolving table various articles can be faced, such as propeller bosses and blades, large valves, cylinders, pipe-flanges, &c.

German Locomotives.—It has been stated in the German press that the German locomotive makers had delivered 2,000 heavy goods and express locomotives to the State railway department. This has now been found to be much exaggerated. The orders from the German railways for the whole of 1916 range between 1,600–1,800 locomotives, and the number delivered by the German locomotive works during the first half of the current year to the State railways does not exceed 750.

The Trade of the Federated Malay States.—We read in the *London and China Telegraph* that in spite of the war the Federated Malay States have had a prosperous year. The revenue for 1915 amounted to 4,757,081*l.*, which was 664,028*l.* over the estimate, and an improvement of 404,254*l.* upon the revenue for the previous year, while the expenditure was 4,997,840*l.* It will be seen that the expenditure exceeded the year's revenue, but it should be explained that the States have considerable reserves, which are being spent in carrying out railway extensions of a far-reaching nature and upon revenue-producing public improvements calculated to develop the country and make it more desirable for European settlers. The surplus balance at the credit of the States at the end of 1915 amounted to 4,838,894*l.*, and they had investments valued at 875,288*l.*, of which 250,773*l.* is invested in the Imperial 4½ per cent. War Loan, 1925–45. Loans to planters represent 368,920*l.* The amount lent to Siam to enable that country to complete its railway system connecting with the Federated Malay States railways was 2,460,000*l.* at the close of the year, while the neighbouring State of Johore has a loan amounting to 787,500*l.* Under the heading of "revenue" the Federated Malay States railways earned 1,071,876*l.*—slightly over the earnings of 1914—while the expenditure amounted to 1,387,065*l.*, which, however, included 671,536*l.* on construction and special services. With a view to economy, public works were curtailed, but work in hand on public buildings was completed, and a good deal done to extend water-works irrigation, anti-malarial works, and the excellent road systems which have already served to open up the country. The expenditure of the Public Works Department amounted to 633,278*l.*

MOTOR-DRIVEN HORIZONTAL TURBINE BORING MACHINE.

CONSTRUCTED BY MESSRS. G. AND A. HARVEY, LIMITED, ENGINEERS, GLASGOW.

(*For Description, see Page* 180.)

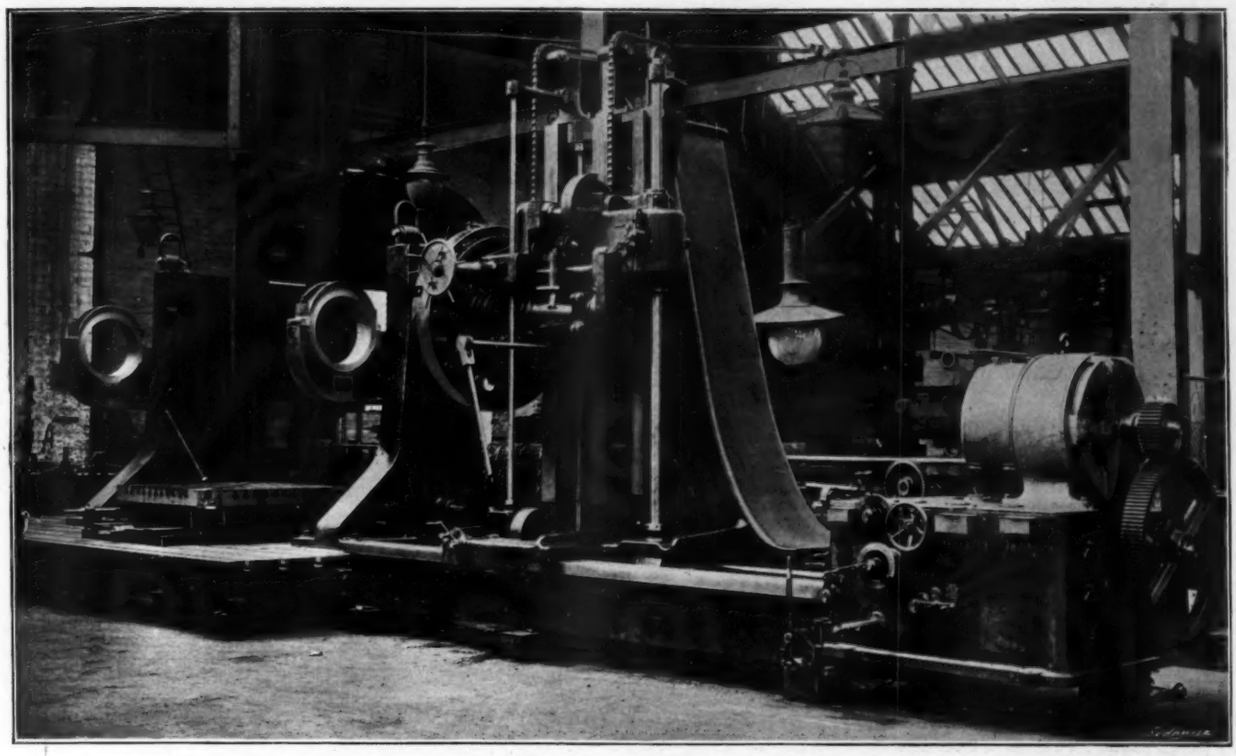


Fig. 7.

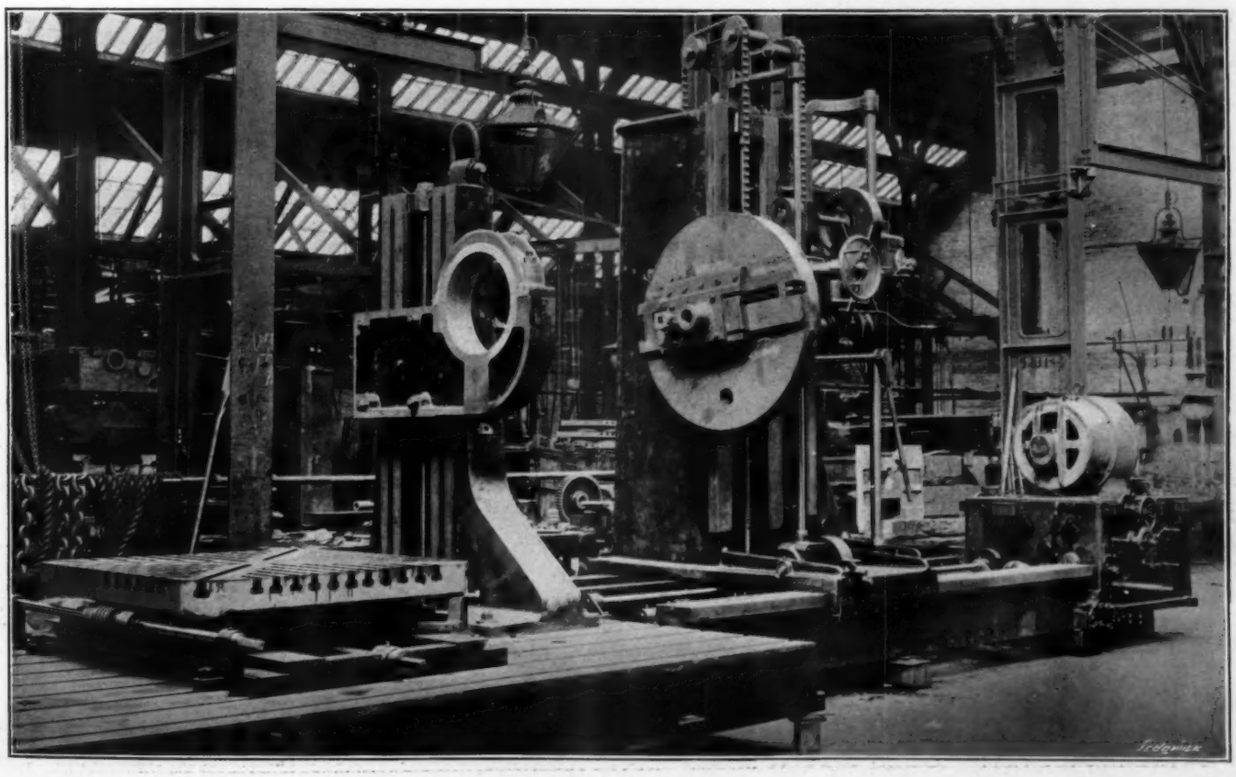


Fig. 8.

(*To face page* 180.)

MESSRS. SCHNEIDER'S GUN, MUNITION AND ARMAMENT WORKS.

(*For Description, see Page* 174.)

Fig. 1. Machining Field-Gun Shells.

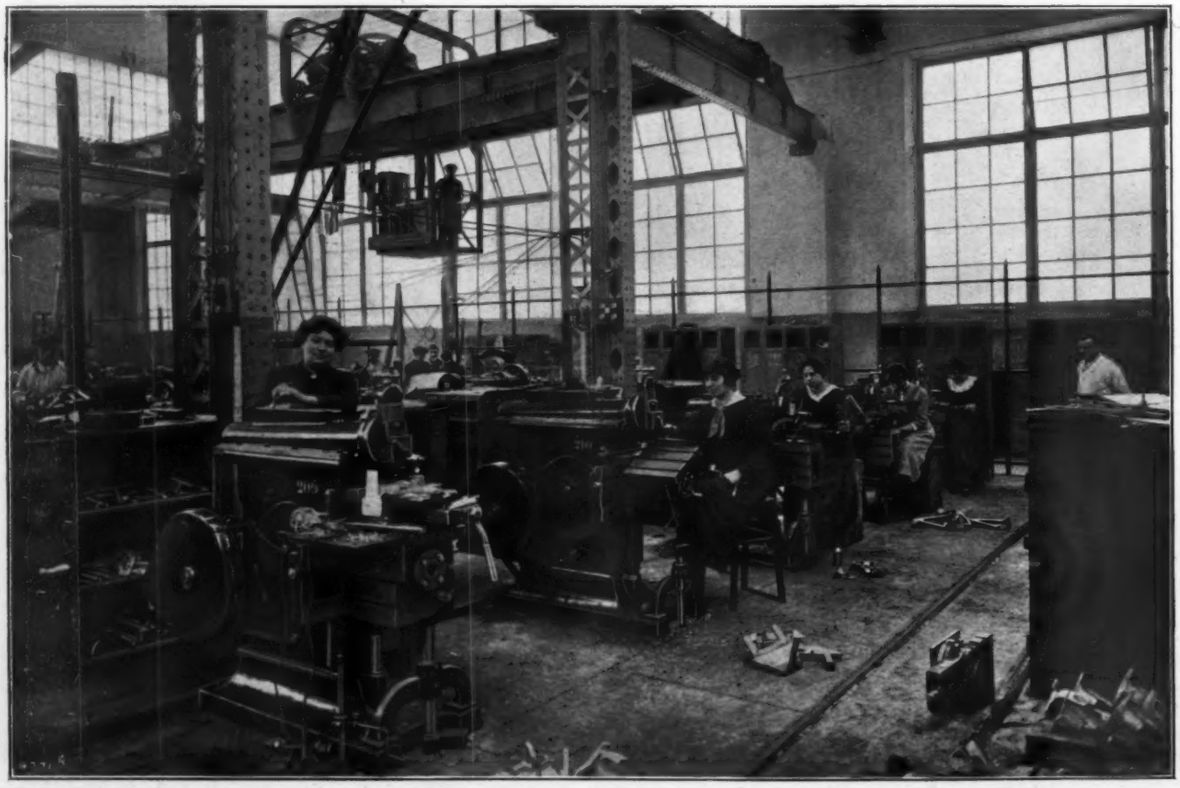


Fig. 2. Machining 75-MM. Gun Parts.

MESSRS. SCHNEIDER'S GUN, MUNITION AND ARMAMENT WORKS.

(*For Description, see Page* 174.)

FIG. 3. VIEW IN A FUSE FACTORY.

FIG. 4. VERIFICATION OF FUSE COMPONENT PARTS.

FIG. 5. MACHINING FIELD-GUN SHELLS.

FIG. 6. FORGING THE HEAD OF A PROJECTILE.

MESSRS. SCHNEIDER'S GUN, MUNITION AND ARMAMENT WORKS.

(*For Description, see Page* 174.)

FIG. 7. VIEW IN A GUN-MACHINING SHOP.

(*To face page* 181.)

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With One One-Page Plate of a MOTOR-DRIVEN HORIZONTAL TURBINE BORING MACHINE, and Three One-Page Plates of MESSRS. SCHNEIDER'S GUN, MUNITION AND ARMAMENT WORKS.

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ENGINEERING.

FRIDAY, AUGUST 25, 1916.

BRITISH INDUSTRIES.

MUCH surprise has been expressed in the political Press at the remarkable manner in which our output of manufactures has been maintained in spite of the very large transfer of men from industrial to military pursuits. We do not think that engineers have felt any surprise whatever, since, if conditions in other trades in any way resembled those with which they were acquainted, it was obvious that the normal output was in many cases very far below what would have been possible with more efficient methods. One well-known engineer, shortly after the outbreak of the war, informed us that the output of his coppersmiths had been tripled. Only a portion of this increase could be attributed to the longer hours. Indeed, long hours of labour and efficiency are seldom associated, a fact which is at length beginning to be recognised by those set in authority over us. A naval or military officer accustomed to a 7-day week, with work in progress the whole time, has perhaps a difficulty in realising that the conditions on ship-board and in a factory are in no way comparable, and the fact that a 24-hour day is unavoidable in the one case affords accordingly no sufficient reason for believing the same system can be adopted without sacrifice of efficiency in ordinary factories.

In the case cited above, some part of the increased output was, no doubt, due to the extra hours, as, for a limited time, men by drawing on their reserves of nervous force can work for long hours without slacking, but in the main the extraordinary improvement in yield must be attributed to a change of methods. Everyone who has worked on the old piecework system must be familiar with cases in which the time spent on a job is intentionally prolonged. The charge-man may have seen clearly methods by the adoption of which the progress of the work might be greatly hastened, but, for reasons for which he is far from altogether to blame, has held by the methods traditional in the shop. In fact, much of the trouble in the labour world has arisen because employers in the past have refused to pay high earnings when their men have made them, the converse to which is that the men in most cases have refused to make the high earnings possible by a full week's work at the rates they demand. If a workman by the exercise of his intelligence doubled his output, the "office" professed to be aghast at the weekly sum earned on piece. That the firm concerned could not afford to pay for mere labour at the rate payable may have been perfectly true, but the point neglected was that the excess was not payment for mere labour, but was for the most part payment for brains. Since mind is the main factor in the creation of wealth (using the term, of course, in its technical signification), a refusal of its due reward is shortsighted in the extreme.

At a large shell-making factory in the London district the shop superintendent was struck by the remarkable record of one man. As is well known, the machines at such establishments are being run by unskilled labour of very varying degrees of intelligence. Investigation in the present case showed that the workman in question, being naturally smart, had improvised all sorts of rigs to facilitate the handling of the work, and was in consequence regularly drawing between 8*l.* and 9*l.* per week, which was much above the average made by other men on the same class of work. In normal times the sole result of his ingenuity would, in too many cases, have been a cut in his piece rates so as to reduce his weekly takings to what the office considered normal. He would not have been permitted to reap a fair reward for his intelligence.

No doubt the course too frequently pursued by the "office" is not altogether without reason. A bad mistake may have been made in fixing prices at the outset, or a not too scrupulous foreman may have tried to arrange a soft job for a personal friend. The office, however, has always claimed the right to vary piece prices on the introduction of new methods, and so long as these improved methods are due to the managing staff the claim is fair enough. It is, however, a very different matter when the workman is himself responsible for the new method, and the immediate and complete appropriation of the product of his intelligence by cutting down prices so as to reduce his weekly takings to their original total cannot be ethically defended.

In this connection the adoption of the Taylor system of time and motion studies, if applied with due consideration and discretion, promises to do away with much injustice. If a workman can improve upon the methods which have been devised as the result of careful investigations of this kind, his excess of earnings cannot be attributed to carelessness or favouritism on the part of his foreman, and he is clearly entitled to benefit. Nothing, however, is more strongly resented by organised labour than the attempt to time operations and study motions. Indeed, the unions would seem to be much less anxious for high rates of wages than for uniform wages, and are apparently opposed to the idea that a workman should reap any material benefit from exceptional skill or ingenuity. If by the exercise of his intelligence a workman attempts to increase his output and pay, the shop steward is very likely to intervene.

In this connection labour must remember that resistance to time and motion studies in this country will not prevent the adoption of this means of promoting efficiency by other nations. French manufacturing engineers are, in fact, making a very close study of the Taylor system and methods allied thereto, and a maintenance of past restrictions here will render successful competition impossible with other countries. Instances can be quoted in which work has been taking six times as long as should be the case under proper conditions. On the other hand, those responsible for the speeding-up of our factories should remember that the new methods may involve some increase in the nervous strain on the workman. If, for example, a skilled man is doing a labourer's work in lifting material on to his machine or bench, the strain on his attention which the skilled operation demands is momentarily relaxed. If, on the other hand, every portion of the work which requires little thought or care is done for him, this relaxation is missing. One large firm in this country, who have very well organised works, recognise this by allowing the men a quarter of an hour for a smoke in the middle of every morning's work. In other cases where the physical strain is great it is also very important that the workman shall have periodical rest. An athlete or an oarsman can incapacitate himself for the rest of the day by a few minutes of strenuous exertion, and in the wonderful reorganisation of the common labour employed at the Bethlehem Steel Works effected by Mr. Taylor it was found necessary to prevent the men working themselves to a standstill in the course of an hour or two, by insisting on them taking frequent short periods of rest.

As bearing on this point great interest attaches to the report recently issued by the Ministry of Munitions on "Industrial Fatigue and its Causes."* The investigations here recorded give, indeed, reasons for believing that the bad timekeeping for which the black squad of our shipyards is somewhat notorious may not be wholly without a physiological excuse. American experience has, indeed, proved conclusively that men if left to themselves are quite likely to attempt to work during the earlier hours of the day at too great a rate, with the result that on the whole the day's output is reduced. A most striking example which confirms this conclusion is quoted in the report above-cited. In one munitions factory, for example, the management made a regulation that the men working on piece in the foundry were to take 15 minutes' rest every hour.

* Cd. 8213, London: Wyman and Sons. Price 1½d.

(To face page 181.)

This was resented by the men, as they thought the output would be lessened and their weekly takings fall. A foreman was therefore appointed to make certain that the rule was obeyed. The result was an actual increase in the hourly output. This case is particularly striking in view of the large proportion of the resting time to the working time, and it would be of great interest and value to have fuller details.

Other cases cited by the Committee are interesting, but less conclusive. In one case it was found that five Sunday volunteer workers did in seven working hours more than eight of the ordinary hands were able as an average to do in 12½ working hours. This may quite possibly be due to the staleness induced by the long hours of the latter, who were working day in and day out, but is by no means conclusive, if the men in question were ordinary mechanics. The latter are at times prone to establish what they consider a "recognised quantity," which may be anything from half to one-sixth of what they could readily do if they really tried to assist the management in bettering the output. It seems probable that something of this kind must be responsible for the differences in output found in another case recorded by the Munitions Committee. In this instance an old-established firm built a new shop, designed, on the basis of their past experience, for an output of 5000 per week of a certain standard munition. The new shop, although manned by new and inexperienced hands, gave an actual output of 13,000 per week, a figure which has not been approached in the older but equally well-equipped shops of the firm. Experience may, in fact, be used to delay work instead of to forward it, and the great improvement made by the raw hands certainly affords ground for suspicion. One factor, however, must not be disregarded. It is possible that the older hands, being skilled mechanics, have been aiming at an unnecessarily high standard of accuracy and finish. It is very difficult indeed to persuade a skilled mechanic used to precise dimensions to turn out a "good enough" job. A skilled joiner's output on carpenter's work, for example, is seldom satisfactory.

RAILWAYS IN NORTHERN RUSSIA.

Few parts of the world, from a commercial and industrial point of view, have recently attracted more attention than the northern portions of the vast Russian Empire, and the endeavours on the part of the Russian Government to open out these huge districts, by means of improved routes of communication, are being watched with much interest. Northern Sweden (Lapland) was first made accessible for industry and civilisation by its railway connection with other parts of the country, and the same is true on an increased scale as regards Northern Russia in connection with the railway from Svanka (on the line Petrograd–Vologda–Vjatka) to Kola. So far these portions of the Empire have only been connected with the southern parts of Russia by the narrow-gauge and inefficient railway from Archangel to Vologda, and with the outer world by shipping which, for a few months of the year, trades to and from Archangel and some minor ports on the White Sea.

Many schemes have, at different times, been discussed for connecting northern Russia with the more central parts of the Empire, but up to the time of the war they had not got beyond this preparatory stage. The war, however, brought northern Russia into unexpected prominence, Archangel being the only accessible port in Russia in Europe, and immense quantities of war material and other commodities were despatched *via* this port. This gave a tremendous impetus to railway construction in northern Russia, and it must be admitted that the Russian Government spared nothing to further the work in question.

To commence with, the narrow-gauge line from Archangel to Vologda was improved and supplied with a material increase of rolling-stock. At the same time the alteration from narrow-gauge to ordinary Russian gauge was taken in hand, and has already been completed several months. Swedish ice-breakers were purchased, by the aid of which the navigation to Archangel was last year kept open three months longer than usual. At the same time new and adequate quays were constructed at Archangel.

This new line of communication will not only become of the greatest value for Russia's international commerce under the present exceptional and difficult conditions, but these railways will in the long run attain to still greater importance by assisting in the exploitation of the immense natural resources of Northern Russia. The Kola peninsula covers an area of some 58,000 sq. miles, but the population is only about 15,000 souls. There is a wealth of fish and game; there are lead deposits, stated to be the richest and purest ever found; these deposits are principally in the vicinity of the Norwegian frontier. There are also gold, copper and other valuable metals. Further, there are deposits of a peculiar black and white granite, which is likely to prove very valuable.

Besides the so-called Murman Railway, which we dealt with in our last issue, there are planned several other railways in these northern parts. A railway from the river Ob to the coast of the White Sea has already been surveyed for some time. The population, both in north-western Siberia and in Archangel, is much interested in the problem of a line of communication between these two districts being solved. It is more especially the country round the two large Siberian rivers Ob and Yenisei, which will profit by these means of communication becoming a reality. The principal sources of wealth of the districts in question are fishing, agriculture and forestry, but the impossibility of getting beyond what may be called local markets has hitherto greatly impeded the development of these resources. The concession for the construction of the line is expected to be granted soon. A number of banking establishments are interested in the scheme, but the construction of the railway will hardly commence till the war is terminated. From the main line two branch lines are projected in a southern direction, one on each side of the Ural Mountains, and these lines will both be connected with the great Siberian Railway.

There are also other railway lines projected in northern Russia, as for instance, a line from Kollas to Archangel, a line from Soroka to Archangel, and one from a point on the Petrosavodsk–Zwanka railway to Njandoma, on the Vologda–Archangel line. These lines, however, are only in the preparatory stage.

In this connection it is of some interest to mention that the possibility of realising the Onega Canal project is again being discussed in Russia. This canal, the object of which is to connect Lake Onega with the White Sea, is to proceed either from the town of Onega, or from the small harbour town of Sumsk, and then to be carried in a south-western and western direction as far as the town of Provjenetz, on Lake Onega. It will no doubt form a connection between the White Sea and the Russian canal system, as Lake Onega on the one side is connected with Petrograd through the River Svir and Lake Ladoga, and on the other side with the Volga river system through several canals and lakes. We may add that we are indebted to a Swedish consular report for many of the facts in this article.

THE BRITISH ASSOCIATION.

The 86th meeting of the British Association, which is to be opened at Newcastle-upon-Tyne on September 5, will, in the strict sense, be the successor to last year's meeting at Manchester. It will again be a strictly scientific gathering, shorn of festivities and popular excursions, and many of the great works on the Tyne that would otherwise have been thrown open to members will hardly be able to receive visitors, though the local secretaries hoped to offer some facilities when sending out invitations to the meeting in April. Instead of beginning on the traditional Wednesday to disperse the Wednesday following, the meeting will commence on a Tuesday and finish its deliberations within that week. Yet it promises well, and if the Manchester meeting of 1915 could scientifically be pronounced a success, as it undoubtedly was, the Newcastle meeting of 1916 ought to be equally so. Many difficulties have certainly become more accentuated during the past year; more members will be kept away from Newcastle by national duties, and the Council of the Association and the local authorities have had to consider anxiously whether the preparations for the meeting—the invitation was tendered in 1913—should be persevered in. But the outlook has brightened, and it would have been a pity to interrupt the long series of meetings that have taken place since 1831 and have so well stood the severe strain of two war years, in Australia in 1914 and at Manchester. There is no body having so broad a scientific basis as the British Association, and in discussing problems arising out of the war—which concern the time following the war not less than the war itself—in their scientific, technological and social aspects, the Association has the power of doing useful work of national importance.

We learnt at school and may still remember that the Romans under Agricola invaded the north of England in 79 A.D., and that the Emperor Publius Aelius Hadrian, accompanied, it is said, by his consort Sabina, came up to the Tyne in 120 and built both the Roman Wall, joining the estuaries of the Tyne and Solway, and the Pons Aelii across the river. The camp of the second station on the fortified wall took its name from the bridge. The wall was to keep the Picts and Scots off; but it did not do so after the Romans had left, and Newcastle was generally considered "very Scottish." The Saxon settlement has by various authorities been identified with the doubtful sites of Pampedon or of Ad Murum, the residence of King Oswi of Northumberland according to Bede; later, the district was known as Monkchester. William the Conqueror ravaged the whole north, especially between the Humber and Tees; his son Robert, of Normandy, erected a castle, which William II, Rufus (brother of Robert) restored, but which was soon destroyed again. In certain ways William Rufus is regarded as the founder of Newcastle. But the present castle—now known as the Old Castle and occupied by the Society of Antiquaries, founded in 1813—dates from the years 1172–1177 and the reign of Henry II. Plantaganet; it gave its name "Newcastle" to the settlement. The new castle was built at an expenditure of 852*l.* 18*s.* 9*d.* at a time when an ox sold for 3*s.* Henry II also established a mint in the town. The Lammas Fair goes back to King John. Henry III granted the good men of Newcastle a licence to dig for coal within and without the walls, and also excluded the Jews from these walls on the burghers' petition. The wars of the first three Edwards brought much suffering to the town. During the Civil War Newcastle was royalist; the Scottish under David Leslie stormed it in 1640—before the outbreak of the Civil War in 1642—and the chronicles say that 10,000 people engaged in coal mining and shipping had to starve. It was at Newcastle, reconquered by the Scots after Marston Moor in 1644, that Charles I was delivered up to the Parliamentary Commissioners in 1647. The stormy times of the Old and the Young Pretenders, 1715 and 1745, once more forced Newcastle to arm for defence. Since then the public peace has not been disturbed up till the present day.

The visitor to the city of Newcastle has to search for relics of Roman masonry; of the Saxon era nothing has survived, and of the old town walls, which were gradually removed after the Union of Scotland and England in 1707, only parts of the Sallyport Gate are still standing. The most prominent church, St. Nicholas, with its graceful spire, a bishop's cathedral since 1882, dates from 1350. The oldest church, St. Andrew's, goes back to the Monkchester era. St. John's was built in the 13th century, probably with blocks from the Roman wall, on the line of which it stands. The house of the Grey Friars (Franciscans) has entirely disappeared; the great scholastic, the *Doctor Subtilis*, John Duns Scotus, a Northumbrian, lived there before going to Paris and Cologne (where he died in 1309). Bishop Ridley, who was burnt at the stake at Oxford in 1555, also hailed from the district. The mediæval bridge over to Gateshead, which was erected upon the foundations of the Pons Aelii, was destroyed by the Flood of 1771. It was replaced by a bridge of nine arches, which impeded shipping too much and soon had to give way to the present swing bridge; it rests on three piers in a total length of 560 ft., half of which can turn. The high level bridge next to it, projected by John Green, would hardly have been built (1849) if Robert Stephenson had not fought for it; it crosses the river, 512 ft. wide, at a height of 112 ft. above

water level, in a length of 1,337 ft. Telegraph wires, joining London and Newcastle, were carried over the bridge. Up till then the Electric Telegraph Company had its offices in Gateshead. In 1868 the Anglo-Danish (later the Great Northern) Telegraph Company established itself in Newcastle, from which six main circuits radiate, over to Norway, Sweden, Denmark, Russia and Japan, the cables starting from Newcastle or from Aberdeen. The Newcastle–Carlisle Railway was opened in 1838, and the Central Station in 1850; the mail coach from Aberdeen to London had passed through Newcastle since 1786. Street lighting by oil lamps was introduced in Newcastle in 1763, lighting by gas in 1818. When the expansion of Newcastle began late in the 18th century, the town, and especially the low-lying parts near the river, were as unsightly or picturesque—according to the visitor's point of view—and as unsanitary as most old towns. Robert Grainger who, since about 1825, did so much to renovate and beautify his native town, replacing slums by fine streets of buildings in classical style, was of humble origin; Grainger-street bears his name. The explosion of 1854, which indirectly facilitated the improvements on the Newcastle quayside, really took place on the Gateshead river bank. Earl Grey's monument and Grey-street commemorate the passing of the Reform Bill (1832). Of other noteworthy men from Newcastle and neighbourhood we mention John Horsley (author of "Brittannia Romana," about 1700); the mathematician, Charles Hutton, who died in London; the historian, John Brand; Lord Chancellor Eldon (John Scott); Admiral Cuthbert Collingwood, Nelson's successor; George Stephenson, born at Wylam, the centenary of whose birth was celebrated at Newcastle in 1881; and his son, Robert Stephenson.

The Royal Free Grammar School owes its foundation in 1525 to Thomas Horsley; the Literary and Philosophical Society was founded in 1793. The College of Medicine, the headquarters of this year's meeting, has, since 1852, been affiliated with the University of Durham. The Durham University College of Physical Science at Newcastle was founded in 1871 by the joint efforts of the University of Durham and the North of England Institute of Mining and Mechanical Engineers; students were soon admitted also to degrees in letters, and when in 1904 a new wing of the college was opened in memory of the late Lord Armstrong, the name "Armstrong College" was adopted. Since 1909 this Armstrong College ranks with the Durham colleges and the College of Medicine as one of the three constituent units of the University. Diplomas are granted also in Engineering, Naval Architecture, Mining, Agriculture and Commerce. The Armstrong College buildings are at present the home of the first Northern General Hospital. Newcastle and Gateshead together counted in 1772 about 30,000 inhabitants; by 1885 that joint population had risen to 226,200; at present it is estimated at 383,500, Newcastle itself having 226,600 inhabitants. Of the total output of coal, iron, and ships in the United Kingdom, about one-fifth, one-third, and one-half respectively come from the north-east coast. The once important chemical industry and the glass manufacture of the Tyne have not kept pace with the astounding development of its engineering works and shipbuilding yards. When the Association met in Newcastle in 1889, there were only nine chemical manufacturing works left of 17 in 1875, and the formerly large number of glass works had dwindled down to seven; but the stained glass industry was reviving, fused silica had become an important novelty, and grindstones, the Portland cement and fire-brick industries, as well as potteries, were, and are, flourishing. Our next article will give some information concerning the present status of the Tyne industries.

This year's meeting will be the fourth that the Association has held at Newcastle. The first visit was paid in August, 1838, when the third Duke of Northumberland presided over a gathering of 2,400 members; and it is of interest to note that the seventh Duke will be one of the Vice-Presidents this year. In 1838 the evening discourses were delivered in the Central Exchange, now the Fine Art Gallery and News Room, and a soirée was held in the Green Market—also a creation of Grainger's—the adjoining shops being for the occasion converted into refreshment stalls. When the Association came to Newcastle again, 25 years later, in August, 1863, Sir William Armstrong addressed a meeting of 3,335 members on the development of railways and ocean shipping. The longitudinal stone tracks of Roman roads, it is interesting to remember, had a gauge of 4 ft. 6 in.; they did not long survive the Empire, but wooden (also iron) tracks, more or less of the same gauge, and laid on wooden sleepers, came up in mediæval days on the Continent for mine transport in cars, sometimes provided with flanged wheels; the Colebrook Dale Ironworks, in 1767, replaced the wood by cast iron plates, which were afterwards made edged occasionally. When Stephenson ran his first locomotive on the Killingworth colliery lines, he raised the gauge to 4 ft. 8½ in., it is said; that would have been a bold step even in those days. The first passenger railway, Stockton–Darlington, was opened in 1825.

On September 11, 1889, the third Newcastle meeting, attended by 2,437 members, was opened by Professor William H. Flower, of the Natural History Museum, South Kensington, by an address on Museums and the arrangement of the ideal museum—quite a worthy subject, but, it must be admitted, one of the driest addresses the Association ever listened to.

There is no apprehension that this year's President elect, Sir Arthur Evans, M.A., D.Litt., F.R.S., Pres.S.A., who resides in Abingdon, on the Thames, will tire his audience by his address. Archæology is too fascinating a subject, and an archæologist has not occupied the chair for a long term of years. The address and the evening discourses, by Professor W. A. Bone, F.R.S., on "Intensified Combustion," and by Dr. P. Chalmers Mitchell, F.R.S., on "Evolution and the War," will be delivered in the Town Hall, on September 7 and 8. The reception room and administration offices will, as in 1889, be in the College of Medicine, in Northumberland Road, in and near which also most of the sections will deliberate. The attendance figure of 1889 will hardly be approached, though teachers and students of the primary and secondary schools of the district will, as in late years, be admitted at half the usual fee (of 1*l.*) as associates. The list of sectional officers was published some months ago. Owing to the special duties of many members and the uncertainty of their movements, however, it has not been possible so far to issue a preliminary programme. Through the courtesy of the Recorders of the Sections to which we have been devoting particular attention, we are, however, able to give the following information on the sectional proceedings. Inquiries as to papers to be presented should be addressed to the Recorders, whose addresses we add.

In Section G, Engineering, Mr. G. G. Stoney, F.R.S., will preside, and Professor G. W. O. Howe, D.Sc. (22, Dorset Road, Merton Park, Surrey), is Recorder. The section will meet in the Mining Institute, which is close to the Central Station, and the communications to be discussed may be grouped under several headings. The question of Standardisation and its Influences on the Engineering Industry will be raised by the Secretary of the Engineering Standard Committee, Mr. C. Le Maistre, successor to Mr. Leslie Robertson, who unfortunately perished together with Lord Kitchener on the Hampshire; the foreword is to be given by Sir John Wolfe Barry. Papers on Limit Gauges by Dr. R. T. Glazebrook, F.R.S., and on the Principles of Similitude by Dr. T. Stanton, F.R.S., both representing the National Physical Laboratory, belong to this group. Radio-telegraphic problems will be dealt with by Professor Howe in a paper on the Calculations of the Capacity of Radio-telegraph Antennæ and the Effects of Masts and Buildings; and by Mr. McLachlan, of Liverpool University, on a paper on Some Characteristic Curves for a Poulsen-Arc Generator. Professor Thornton will present a further communication on the Influence of Pressure on Ignition, and Mr. H. T. Newbigin, A.M.Inst.C.E., of Newcastle, will speak on Pressure Oil Film for Lubrication. In a joint meeting with the Chemical Section B, the Fuel Economy Report will be discussed, and some account will be given of the North-East Power Scheme; Mr. C. H. Merz, M.Inst.C.E., is one of the vice-presidents of the section.

The programme of Section B, Chemistry, will not be less instructive and important, and will differ considerably from the customary programme of B. The officers of the section wished to specialise in matters arising out of the war and problems of national importance, and as the war becomes more and more a matter for the engineer and the chemist, so Sections G and B become the really important sections. We have mentioned the joint discussion with G on fuel economy; a whole day will be devoted to this discussion. The fuel question will further be debated in conjunction with Section C, Geology, with regard to the Investigation of the Chemical and Microscopical Characters of different Varieties of Coal, with a view to their most effective Utilisation as Fuel and to the Extraction of Bye-Products. The other group of communications will concern the chemical industries of the country, and an exhibition of British-made chemicals and apparatus is being arranged to illustrate the progress made in replacing German goods. Mr. F. Howard Carr, F.I.C., will introduce a discussion on the Future of Organic Chemical Industries in this Country; Mr. C. H. Whitaker (from "British Dyes") will speak on the British Coal Tar Colour Industry in Peace and War; and papers on the manufacture of Fine Chemicals in this Country are expected. There will also be a demonstration on Stepped Ignition of Gases, by Dr. Thornton. The section will meet in the College of Medicine under the Presidency of Professor G. G. Henderson, M.A., F.R.S., of Glasgow; Mr. A. Holt, D.Sc. (of Dowsefield, Allerton-road, Liverpool), is the Recorder.

The war will not directly enter into the deliberations of Section A, Mathematical and Physical Science, which will meet in Trinity Church Hall, close to the College of Medicine, under the Presidency of Professor A. N. Whitehead, F.R.S., Professor of Applied Mathematics at the Imperial College of Science; Professor A. S. Eddington, F.R.S. (the Observatory, Cambridge), is Recorder. Two discussions have been arranged for. The first, on Gravitation and the Theory of Relativity, will be opened by Mr. E. Cunningham, who will be followed by Professor A. S. Eddington, J. W. Nicholson, and Dr. P. E. Shaw. The second, on Osmotic Pressure, is to be opened by Professor A. W. Porter, F.R.S., and the Earl of Berkeley, Drs. F. Tinker, Shorter, G. Senter, will take part. The papers by Professor H. H. Turner, F.R.S., on Measurement of Time, and by Mr. E. Rutherford, on X-Ray Spectra of the Elements, will be of a general industrial character; and that will also apply to the question to be raised by Professor W. M. Hicks, F.R.S., Can the Frequencies of Spectral Lines be represented as a Function of their Order? Dr. R. T. Beatty will discuss the Measurement of the Energy in Spectral Lines, and Professor J. C. McLennan, F.R.S., Ionisation Potentials. All these problems have been much debated of late. The Rev. A. L. Cortie, S.J., will offer a further contribution on the Efficiency of Sunspots in relation to Terrestrial and Magnetic Phenomena, and Mr. S. Chapman will refer to certain aspects of the Kinetic Theory of Gases. Mathematical papers are promised by Professor G. N. Watson on Oscillatory and Asymptotic Series, and by Professor R. W. Genese on the Practical Treatment of the Standard Cubic Equation.

Thus the parent section, A, has a very interesting programme, and we may on the whole look forward to an instructive, though probably not large meeting. There has been no change in the general officers of the Association; the Treasurer, Professor John Perry, F.R.S., and the General Secretaries, Professors W. A. Herdman, F.R.S., and H. H. Turner, F.R.S. Professor Herdman lost his only son, George Andrew Herdman, early in July on the Somme—a very promising and original scientist, zoologist, like his father, who had already made a name, at Trinity College as an investigator of biochemical problems, in the twenty years of his life. The Assistant Secretary, Mr. H. C. Howarth, M.A., and the Assistant Treasurer, Mr. H. C. Stewardson, also continue in office. The offices of the Association in Burlington House will close on August 30, and the offices of the local secretaries, in Bolbec Hall, Newcastle, will close on September 2. Professor P. Phillips Bedson, D.Sc., and Mr. E. W. Fraser

Smith, are the local secretaries. Lectures to the public, which have proved so attractive at previous meetings, are to be given at Newcastle, Ashington, Durham and Sunderland.

FRENCH RAILWAY TRAFFIC AND THE WAR.

In our former articles* on the French railway systems we dealt with the effect of the war upon their commercial traffic following closely upon the outbreak of hostilities. A review of the conditions which prevailed in the year 1915 will be found of interest.

The two companies which of a necessity have suffered most by the war are the Northern and the Eastern of France Railway systems, both of which were compelled in the course of 1915 partly to suspend at times the whole of their commercial traffic to meet the military requirements of the nation. It is quite plain, therefore, that in the case of both these systems it is impossible to establish comparisons between the results obtained in 1915 and the former normal results, even when leaving entirely out of account the temporary losses due to destruction of plant and of accumulated stores. Besides this, the working of the lines which have remained comparatively free for commercial traffic was, and is still carried out under quite abnormal conditions and quite outside all tariff provisions, which latter, on the other hand, were drawn up on the basis of the working of the system as a whole. Moreover, it was ascertained early in the war that the conditions of modern warfare make a demand upon the railways of a country the full extent of which had hardly been realised, one result being that the tariffs for military transports, which the railway companies had arranged for in peace time with the State, were shown to be entirely inadequate.

If we take in the first place the financial results for 1915 of the Northern of France Railway Company, which, temporarily, has no further connection with the Belgian Railway system, we find that in 1915 the working receipts amounted to 171,500,000 francs (6,860,000*l.*), including the financial settlements made with other French and foreign railways, and including also the payments on account received for military transports. This total was less by 69,000,000 francs (2,760,000*l.*) than the total for 1914, when normal working prevailed for more than half the year. It is true that the company received about 28,000,000 francs (1,120,000*l.*) more in 1915 than in 1914 for military transports, but it lost 43,500,000 francs (1,740,000*l.*) in passenger traffic, about an equal sum in slow goods traffic, and 8,500,000 francs (340,000*l.*) in express goods traffic. In regard to expenditure, the cost of working was far from being covered by the tariffs which, as a matter of course, do not take into account the increased cost of materials, particularly coal and metals, an increased cost which will continue to rule long after peace is declared and which will inevitably lead to an advance in the tariffs. The working expenses in 1915 formed a total of about 149,000,000 francs (5,960,000*l.*) without counting maintenance, repairs, losses, destruction of stock, &c. In the latter figure for total expenditure the outlay of the central Board, entered for slightly less than 19,000,000 francs (760,000*l.*); the working expenses proper formed a total of about 46,000,000 francs (1,840,000*l.*); running expenses and rolling-stock reached a total of 72,000,000 francs (2,880,000*l.*); and supervision a total of 12,000,000 francs (480,000*l.*). There remained, therefore, a surplus of about 23,000,000 francs (920,000*l.*). The Northern Company can make no further call upon the State in regard to guarantee of interest on behalf of its shareholders, and since it had to meet over 110,000,000 francs (4,400,000*l.*) in the way of charges upon share and bond capital, and 20,000,000 francs (800,000*l.*) provided in its convention with the State to complement the share revenue, the deficiency for 1915 amounted, therefore, to about 107,000,000 francs (4,280,000*l.*), which had to be placed to capital account. In order to obtain necessary resources the Northern Company sold during 1915, 223,000 bonds, which brought in a net amount of about 97,000,000 francs (3,880,000*l.*). The selling price was under that for 1914 and 1913, the 5 per cent. bonds having fetched 446 francs (17*l.* 16*s.* 6*d.*), the 2½ per cent. bonds about 331 francs (13*l.* 4*s.* 6*d.*). The average rate of interest and redemption rose from 5.51 to 6.71 per cent. These results will not dangerously affect the strong position in which the Northern Company stands; in the course of the same year, 1915, it had repaid about 16,000,000 francs (640,000*l.*) worth of bonds. This well-established company, nevertheless, has to face a most heavy ordeal.

The Eastern of France Railway Company has also greatly suffered from the consequences of the war. Its gross working receipts hardly exceeded 191,000,000 francs (7,640,000*l.*), whereas in normal times they amounted to about 305,000,000 francs (12,200,000*l.*). It was hit not only from the point of view of interruption or complete suspension of traffic and rise in the price of all commodities, particularly coal, but also in regard to the convention established in 1898 between the State and the railway companies and governing the charges for military transports in war time already alluded to. The Convention of 1898 did not provide for the eventuality of a railway system being placed for a long period under the absolute direction of the military authorities, when the whole of its commercial interests are of a necessity sacrificed in favour of the greater interests of national defence. At the close of hostilities it will be incumbent upon the authorities to revise the convention in such a way that the railway companies be not compelled to undergo such losses as those proceeding from the present state of war.

It is to be noted that the Eastern Company did not, during the year, completely suspend its work of construction and equipment during the present war; it spent about 20,000,000 francs (800,000*l.*) in the doubling and quadrupling of lines in proximity to Paris. The above figure of 191,000,000 francs in receipts is less than the total for 1914 by 37,000,000 francs (1,480,000*l.*), or 16.50 per cent. The decrease compared with the figure for 1913 is roughly 37 per cent. The system was, and is still deprived of about one-quarter of its total developed length. It is satisfactory to note, however, that commercial traffic is increasing notwithstanding the difficulties which have to be contended with; the monthly commercial traffic receipts during the period from August to December, 1914, averaged 6,500,000 francs (260,000*l.*), and they amounted to 9,500,000 francs (380,000*l.*) for the corresponding period of 1915. Passenger traffic brought in less than 32,500,000 francs (1,300,000*l.*) in 1915, or a decrease of about 45 per cent. compared with 1914, five months only of which were covered by the war. Express goods traffic produced 13,500,000 francs (540,000*l.*) instead of 18,000,000 francs (720,000*l.*). Ordinary goods traffic which yielded 188,000,000 francs (7,520,000*l.*) in 1913, 116,500,000 francs (4,660,000*l.*) in 1914, only yielded 64,000,000 francs (2,560,000*l.*) in 1915. Military traffic entered into the receipts for about 32,000,000 francs (1,280,000*l.*) for the five last months of 1914, whilst the sum for this traffic in 1915 was 78,000,000 francs (3,120,000*l.*). The receipts per kilometre of the system, which were about 60,000 francs (3,860*l.* per mile) in 1913, fell to 37,400 (2,407*l.* per mile) in 1915; if the lines actually worked be alone taken into consideration this latter figure would become 49,500 francs (3,180*l.* per mile). Commercial traffic on the Eastern of France had been rendered all the more difficult by the fact that the company had lost about 14,000 goods and passenger wagons, which had remained either on the enemy's German lines, or in Belgium or, again, in the portion of French territory temporarily invaded.

The working expenses of the Eastern of France Railway reached in 1915 a total of 161,500,000 francs (6,460,000*l.*), or 14,000,000 francs (560,000*l.*) less than the total for 1914 and over 26,000,000 francs (1,040,000*l.*) less than that for 1913, which is explained by the great reduction in the number of train-kilometres run. On the other hand, the company had to bear an excess charge of 7,000,000 francs (280,000*l.*) owing to the advance in the price of coal. The working expenses proper formed a total of about 58,000,000 francs (2,320,000*l.*); under the heading running expenses and rolling-stock there was a total of about 64,000,000 francs (2,560,000*l.*), and a further sum of 17,000,000 francs (680,000*l.*) had been spent on tracks and work on the lines. The ratio of working expenses to gross receipts exceeded 84 per cent.; it was 76.5 per cent. in 1914 and about 61 per cent. in 1913. The company, like the other French railway companies, is most generous to its staff and spent large sums for the latter's welfare. It paid two weeks' wage to each man on his leaving for military duties, and to the wives of their men serving under the Colours half the man's salary or wage, payable monthly, besides 5 pence per day and per child under 16 years of age. A special grant was made to the men who remained in the company's service in the localities which were exposed to bombardment by the enemy. All expenditure under these heads formed about 121 per cent. of the annual revenue of the shareholders. Owing to charges on loans and the shareholders' revenue, the year closed with a deficit of about 88,000,000 francs (3,520,000*l.*); the deficit in 1914 was about 62,000,000 francs (2,480,000*l.*). In 1913, the excess of receipts over expenditure was 28,000,000 francs (1,120,000*l.*).

The Paris-Orléans Railway Company did not directly suffer from the war, as had been the case with the two companies referred to above, but its traffic nevertheless decreased considerably. The gross receipts were 332,000,000 francs (13,280,000*l.*), and the expenditure about 202,500,000 francs (8,100,000*l.*). The ratio of working expenses to gross receipts was about 61 per cent.; it was 59 per cent. in 1913 and 65 per cent. in 1914. The gross receipts exceeded by about 51,000,000 francs (2,040,000*l.*) those of 1914, owing to a greater activity in commercial traffic. Military traffic remained high on this system in 1915 and brought in substantial receipts; but in the case of this railway, as in that of the other French railway companies, the convention entered into with the State was one which led to a loss in revenue. In the course of 1915, the company carried some 3,700,000 officers and men, 582,000 horses, 11,000 guns and limbers, 185,000 military wagons, in a total of over 30,000 military trains. The number of civilian passengers carried only amounted to 40,500,000, or 31 per cent. less than in 1913 and 11 per cent. less than in 1914. The civilian passenger traffic produced about 74,000,000 francs (2,960,000*l.*). The proportion of military traffic at quarter fare, not counting the soldiers who travel with a military pass in war time, was 22.5 per cent. in 1915, as against 7 per cent. in 1913, and in 1915 their number exceeded 9,000,000. The decrease in express goods traffic in 1915 amounted to about 20 per cent., compared with the figure for 1913, and to about 4 per cent. compared with that for 1914. Agricultural produce traffic was particularly low owing to lack of labour on the land. The returns on ordinary goods traffic yielded less than 125,000,000 francs (5,000,000*l.*), or 8 per cent. less than 1913, but 23 per cent. above the figure for 1914. Coal traffic, in tonnage, showed an increase of 33 per cent. compared with 1913; there were further increases of 39 per cent. on corn and cereals, 44 per cent. on dry vegetables, 43 per cent. on chemicals, 58 per cent. on resinous and leguminous products and 37 per cent. on various metallurgical products, to meet the demands of the military authorities, the goods in question being in great part imported into France. The number of ton-kilometres run was 30 per cent. above the figure for 1914 and 37 per cent. above that for 1913, corresponding, therefore, to greater working expenses and, on the other hand, paid at the reduced military rates provided for in the company's convention with the State. Traffic was carried out with no special difficulty, although the company lost the services of 6,300 members of its staff who were called to the Colours and were partly replaced by women.

The working of the Paris-Orléans system in 1915, taking all figures under expenditure, resulted in an insufficiency of revenue to the extent of 20,000,000 francs (800,000*l.*), which the Treasury will have to make good in the shape of guarantee of interest to the shareholders. This sum corresponds approximately to the increased price the railway had been compelled to pay for coal.

The South of France Railway Company is a small

* See ENGINEERING, vol. c., page 646, and page 17 *ante*.

company relatively. The gross receipts amounted to about 141,500,000 francs (5,660,000*l.*), the net receipts to 135,000,000 francs (5,400,000*l.*). These figures showed an improvement on those for 1914, notwithstanding the confusion caused by the war in industrial, agricultural and commercial pursuits throughout the country, and notwithstanding also the sacrifices the company had to make from the point of view of military transports. These latter brought in 12,500,000 francs (500,000*l.*) for the carriage, during the year, of 600,000 men, 96,000 horses, 620,000 tons of stores, 585,000 tons of various military goods and 5,650 trucks of cattle for the troops. Passenger traffic yielded 39,500,000 francs (1,580,000*l.*), or about 4,000,000 francs (160,000*l.*) less than in 1914; ordinary goods traffic produced 69,000,000 (2,760,000*l.*), or 4,000,000 francs above the figure for 1914. The system serves a large number of thermal resorts in the South of France, and in 1915 there were, as compared with 1913, as many as 5,000,000 less visitors to these resorts. The working expenses reached a total of 81,500,000 francs (3,260,000*l.*), an increase of 5.5 per cent. compared with those for 1914. General expenses and expenditure on stock and in traffic entered into the increase, whilst the figures under other headings showed a reduction. The company had also to pay extremely dearly for coal; in 1915, it purchased three-fourths of its coal requirements in Great Britain, as against one-half only in normal times. The fuel bill, which amounted to 9,800,000 francs (392,000*l.*) in 1914, exceeded 17,000,000 francs (680,000*l.*) in 1915. The general result for the year was a balance on the wrong side of 17,500,000 francs (700,000*l.*), which will be advanced by the State to cover charges on capital and the interest on shares as per the convention passed with the State in 1883.

There remains to report the working of the very important system belonging to the Paris-Lyons-Mediterranean. As a typical example of the activity of this company we may mention the fact that during the summer of 1915 it succeeded in re-establishing in part its motor-car services on the Alpine roads, which it had established previous to the war for the benefit of excursionists. The flower traffic, as also the fruit and agricultural produce traffic, fell considerably during 1915 owing to lack of labour. But notwithstanding all the difficulties which the company had to contend with, its working receipts, which fell to 503,000,000 francs (20,120,000*l.*) in 1914, from a total of 596,000,000 francs (23,840,000*l.*) in 1913, rose to 558,000,000 francs (22,320,000*l.*) in 1915; this latter figure is approximately equal to that for the year 1911, and showed progress when compared with the results for the previous year, 1914. The company succeeded in keeping working expenses down to a total of 316,000,000 francs (12,640,000*l.*), as compared with 313,000,000 francs (12,520,000*l.*) in 1914 and 340,000,000 francs (13,600,000*l.*) in 1913. The receipts, which had fallen to less than 191,000,000 francs (7,640,000*l.*) in 1914, rose to approximately 242,000,000 francs (9,680,000*l.*) in 1915, or close upon the corresponding figure for 1911. This company, like all the other French railway companies, had shown, and is continuing to show, a marked degree of elasticity and efficient economy. In the receipts for 1915, those for military traffic entered for 95,000,000 francs (3,800,000*l.*), but industrial and agricultural traffic still continued to play an important part in the activity of this system, so much so that the commercial receipts for goods traffic during the third quarter of 1915 were 93 per cent. of those for the corresponding period of 1913. Taking the year 1915 as a whole, the passenger traffic receipts were 40 per cent. less and the goods traffic receipts 11 per cent. less than those for 1913. Charges on rolling-stock, running expenses and the rise in the price of coal led to heavy extra expenditure. The Paris-Lyons-Mediterranean Company, although it serves several French colliery districts, was compelled in 1915 to import three-fifths of the coal it required, and this imported coal mostly came to Marseilles at very high freight rates. During the same year it spent over 33,000,000 francs (1,320,000*l.*) upon its benevolent institutions in favour of its staff. Notwithstanding the difficulties it had to contend with, the company succeeded in paying the shareholders a dividend after having met all its charges on loans and having borrowed a comparatively small amount in the shape of a bond issue, a result for which it is to be congratulated, seeing the conditions under which it had been achieved.

The above brief account points to the vitality of the French railway companies; it points also to the recovery of business in France and to the services which these companies render the nation, in furthering both its military needs and its commerical and industrial life.

NOTES.

Electric Power for the Gotthard Railway.

The introduction of an electric service on the Swiss Federal Railways—Schweizer Bundesbahnen, abbreviated S.B.B.—and the electric system to be adopted have been discussed for several years, but the erection of the hydro-electric plants for the Gotthard railway is only being started. In 1907 the Gotthardbahn—then a company, since Federal—obtained concessions from the cantons of Uri and Tessin, north and south of the Gotthard, for the utilisation of the water power of the Upper Reuss (which flows into the lake of Lucerne) and of the Upper Leventina, and five hydro-electric stations were projected. For the electrification of the section Erstfeld–Bellinzona, with which a start is to be made, two of these plants will be sufficient, and Amsteg and Lake Ritom, north and south of the Gotthard, have been selected. Either of these power stations will be sufficiently powerful to maintain the service if it should be necessary, but they are to be combined. The Reuss carries most water during the summer, when Lake Ritom stores up water which can help during the winter. Above Amsteg a lake of 200,000 cub. m. capacity is to be created; without erecting a dam at Lake Ritom, 26,000 h.p. would be available all the twenty-four hours of a day, while the erection of a dam at Ritom would raise the water level by 7 m. and bring the total power available up to 30,000 h.p. The later extensions of the plant will place 70,000 or 80,000 h.p. at the disposal of the railway department. As regards the Amsteg station, the water of the Reuss is, near Pfaffensprung, caught in a gorge which is closed by a dam 25 m. in height. In order to prevent the lake from being choked with detritus, the Reuss is to be deflected by a tunnel, 282 m. in length and 21 sq. m. cross section, and the surface river water is alone to flow over a weir into the lake; this deflection is on an incline of 0.5 per cent. From the lake the water flows through a conduit, 7,350 m. long, 6.5 sq. m. section, with a fall of 0.15 per cent., to a collecting basin blasted out of the rock. From this basin two (later four) hydraulic pipes, tapering from 1,600 to 1,400 mm. diameter, 480 m. long, take the water almost vertically down to the turbine house. These hydraulic pipes cross the Gotthard railway track. Each pipe feeds two turbines of the jet-impulse type; the tail race of each turbine will have a length of 25 m. before joining the common race, 220 m. long, 10 sq. m. in cross section; a water meter is to be inserted in the former section, and the water is to be returned to the Reuss river. A turbine, a single-phase generator and a transformer will form one unit of 10,000 h.p. maximum; current of 66,000 volts is to be taken from the bus bars to the cables; the engine motors are to be worked at 7,500 or 15,000 volts. The auxiliary machinery and light dynamos will be on a special continuous-current circuit. The Ritom Lake is credited with containing 25,000,000 cub. m. of water, and it is intended to tap it 30 m. below the present water level. The average rate of discharge of the lake is 1 cub. m. per second, according to observations extending over six years; when tapped, as intended, near the Hôtel Piora, 19,000,000 cub. m. will be available. The conduit will have a length of 873 m., a cross-section of about 3 sq. m., and an inclination of 0.5 per cent. The collecting basin is likewise to be blasted, and will consist of a vertical shaft, 5 m. in diameter, widening above to a diameter of 10 m. Three pressure pipes, from 1,100 to 900 mm. in diameter, 1,413 m. long, will convey the water down to the turbine house; the fall of these pipes is not stated in the *Schweizerische Bauzeitung*, of July 22 and 29, from which we quote; it is mentioned, however, that a rope railway will run close to the pipe line to facilitate the erection. It is also pointed out that the beauty of the scenery will be respected and preserved; but our contemporary wishes to have a further guarantee as to the protection of Nature, and we certainly understand his emphasising this desire.

Overhead Conductors of Aluminium, Zinc, Iron.

The question of substitutes for copper as material for electric conductors is seriously exercising countries like Switzerland which stand outside the war and which, one might think, have in their own aluminium a good substitute. The Neuhausen aluminium works, near Schaffhausen, are on Swiss territory, it will be remembered. But there is a general dearth of raw materials for aluminium manufacture, and so far very little aluminium has been used for conductors in Switzerland. The Swiss Elektrotechnische Verein discussed the problems last spring in connection with reports and papers by Professor Wyssling, Mr. A. Burri, and others. Taking the conductivity of electrolytic copper as 100, those of Al, Zn, Fe are 58.4, 28.5, 12.5, and the temperature coefficients of the four metals 0.004, 0.04, 0.0039, 0.0053. Thus aluminium might well compete with copper, and as long as its price is 1.89 times that of copper it would be the cheaper conductor, according to Wyssling. There are mechanical difficulties, of course, but they have been overcome. As regards zinc, wire was hardly used until a few years ago, and zinc wire is not so reliable as iron wire. There may be hollows and brittle portions in an apparently uniform zinc wire, and the wire should in its making not be heated up to 100 deg. C. for long periods, lest its strength and pliability suffer. Really hot steam is directly dangerous to zinc, and zinc wires should not be suspended in damp, hot atmospheres. On the whole the metal can hardly be recommended for overhead lines. It may be used when properly protected, however, and bus bars of zinc are feasible; they should be guarded against damp contact with other metals, and be covered with varnish in such cases. To a certain extent zinc wire is used in distribution cables by German electricians at present. The objection to iron wire is not so much the low conductivity itself as the fact that the resistance to alternating currents is, owing to the skin effect, influenced by the current intensity and the frequency. Professor W. Peukert and other German electricians have again investigated these features. Peukert tried various frequencies up to 300 periods per second. The voltage drop and energy consumption were greater on alternating-current circuits than on continuous-current circuits, of course. On 60-period circuits of 9.6 amperes a conductor consisting of seven strands of iron wire, each 0.67 mm. in diameter, showed an increased voltage drop of 5.4 per cent. and an increased energy consumption of 4.9 per cent. The *Verband Deutscher Elektrotechniker* issued last year regulations concerning the use of iron wires as conductors for alternating currents. Such wires are not to be made in sizes exceeding 2.5 sq. mm. in cross-section. Larger conductors should be made up of at least seven strands of wires, 1.4 mm. in diameter, these wires to be provided with paper insulation within an iron, lead-covered sheath. This style of wire is designated "M.P." wire, and is recommended only for low-tension and dry localities; on phase circuits the sheath may serve as the neutral wire. In Switzerland galvanised-iron wire is recommended for high-tension lines, at any rate for short sections. Burri has compiled tables for their installation. For house installations in particular the use of iron wire, advocated in Germany, seems quite justified; matters were different in the early days, when something like 4 watts was wanted per candle. The experiments of Peukert to which we referred have led him to the construction of a new frequency meter which is based upon the following consideration. As long as the current through an iron coil does not vary, the effective resistance of the iron changes with the frequency, and may be obtained from wattmeter and amperemeter seatings. With constant current the inductive resistance should follow the same rule, and the potential difference at the ends of the coil should depend upon the frequency.

A voltmeter calibrated to frequencies should thus furnish a frequency meter of wide range, provided that the current be kept constant within the potential variations to be expected. This constancy is obtained by connecting a Nernst resistance, fine iron wire stretched in a hydrogen atmosphere, in series with the coil. The frequencies ranged up to 500 periods per second in the experiments; the resistance increases within this range may be large, *e.g.*, from 6.2 to 13.5 ohms in a 1.5 mm. wire at 2 amperes; with a coil of 800 turns of this wire the tension increased from 12.5 to 65 volts at 1.15 ampere constant when the frequency was raised up to 500 cycles.

LITERATURE.

Elements of Highway Engineering. By Arthur H. Blanchard, C.E., A.M., Professor in charge of the Graduate Course in Highway Engineering in Columbia University. New York: John Wiley and Sons: 1915. [Price 12*s.* 6*d.* net.]

When increasing traffic demanded permanent and more firmly constructed roads, a demand which in a great measure was supplied by MacAdam and Telford, much of the improvement effected on the road was contributed by those who used it. MacAdam chose the materials, and showed how they could be best employed, but the work of consolidating the crust had to be performed by the vehicular traffic, which was expected to do the roller work of forcing the stones into a closely compacted mass. In time the discomfort attaching to this process became unbearable, and the introduction of the heavy steam roller, with copious earth filling of the interstices, and much watering, was hailed with delight. The roller proved expeditious in use and removed much of the temporary annoyance against which the road user rebelled, but brought with it new evils for a younger generation to overcome. For with improvement the standard of excellence had risen. Rigidity and permanence, qualities that seemed all-important to those who remembered the quagmires that had done duty for highways, no longer satisfied a more exacting public, who expected locomotion to be smooth and noiseless, who demanded that the surface of the roadway should be dustless, capable of being easily cleaned, non-slippery for horses and all classes of vehicles, possess a low tractive resistance, remain impervious to weather, and present an agreeable appearance. Above all, such a roadway must be inexpensive to make, and cheap to maintain in good condition.

Such demands have called for a special class of well-trained engineers, who would devote the requisite time and energy to the study of the problems of construction and maintenance connected with highway engineering no less than to those of administration, organisation, and economics. As a consequence, several treatises have appeared of late years intended to encourage the consideration of the principles underlying this branch of engineering, embodying much recently acquired experience and disseminating much valuable information. The manual now under notice, intended mainly for students in engineering schools, is a very good specimen of this class of text-book, but is naturally more particularly adapted to American practice. Necessarily it covers a wide ground, for it aims at embracing the whole scheme of road construction, from the consideration of the circumstances that determine the direction and laying out, the mode of treating the foundation, drainage, the choice of materials for the crust, their properties and manipulation, the method of laying, and the conditions that make for sound surface as well as those that promote deterioration. Moreover, since in America mechanical appliances displace hand labour to a large extent, the author has thought it necessary to describe many patent machines designed to this end. Add to this comprehensive scheme sundry historical sketches, slight excursions into the chemistry of bitumens, with dissertations on the desirability and methods of testing materials, and it can be easily imagined that there are many lacunæ to be filled by oral instruction.

The United States offers a large and lucrative field to the enterprise of the highway engineer. In many of the States the roads are undergoing reconstruction, being adapted for a larger and more rapid traffic, and huge sums are being spent in replacing the original earth-made roads that sufficed in days of lighter vehicles. In 1904 money grants to the amount of 79 million dollars were voted for road improvements, and 10 years later this sum had increased to 225 millions. The earth roads still hold sway over some 90 per cent. of the total mileage, or about two million miles, and apparently the ambition of many States and municipalities is to replace these with some type of paved road. The task is gigantic both in labour and expenditure, and in the opinion of the author not warranted from the standpoint of either economy or efficiency. The great objection to the earth road is the necessity of constant watchfulness in maintenance, with the view of keeping the surface smooth and well crowned, so as to shed the water as rapidly as possible. In some States the Road Commissioners are empowered to have the earth roads "dragged" at all seasons of the year, whenever it was deemed to be beneficial, contracting with the adjoining landowners at a rate not exceeding one dollar per mile for a road 20 ft. wide. Much of this necessary work apparently falls on the residents and frontagers, an arrangement that becomes irksome and liable to prove ineffectual, for repairs are likely to be performed at times convenient to those who possess the necessary machinery, rather than when demanded by the state of the road. This grievance is aggravated in some districts, where labour can be substituted for cash payments. We have passed through that phase of construction and repair work in this country and know its defects. It implies unintelligent administration, inefficient, because irregularly employed, workmen, and a want of cohesion and uniformity in time and machinery between the several operating teams. Organisation, skilfully and scientifically directed, is a necessity that cannot be too urgently insisted upon. The want of sound control under competently trained officials is wasteful and the sign of a bad system. The author, as we think rightly, emphasises the need of entrusting road construction and maintenance to those who have been trained for the work. The day of the amateur road-maker is past: he is the relic of the time when every pioneer had to make his own road. His traditions survive in the road commissioners of to-day, who too frequently hamper the engineer by unwarranted interference and impossible suggestions. The exercise of political influence in the selection of commissioners aggravates an evil that is rendered well-nigh intolerable by divided responsibility between the State and the county.

It is a commonplace to say that experience has not evolved any best road that can be recommended under all conditions. To enumerate the social and economic factors that determine or warrant road construction is easy, but in practice compromise is usually necessary, for conflicting interests have to be harmonised. From the social point of view the road when made should foster the commercial, agricultural, and industrial interests of the community. It should also serve the largest number of people practicable. The engineer would urge the importance of good natural drainage, of stable natural foundation, the desirability of keeping the gradients slight without incurring the inconvenience of sharp curves. These are generalities with which Professor Blanchard deals thoroughly, but the attention and the criticism of the public are mainly fixed on the finished surface, and to the various forms this may assume the author devotes very considerable attention, though he does not neglect the essential point in all road construction, the artificial foundation intended to reinforce the supporting power of the superficial strata. The crust, the wearing course, assumes many forms, the problem of selection depending upon many variable factors, few of which can be accurately known at the moment of projecting the scheme, and none can be adequately estimated for a few years in advance. The water-bound broken stone road, when built with proper materials, is deservedly held in high consideration for horse-drawn traffic. The weight that can be economically transported by horse-traction is restricted, and the limitations have long been recognised, ensuring the approximate weight any highway would have to carry. Increased weight meant lower speed, and the wearing course was not submitted to the two main causes of deterioration at the same time. The advent of the motor car, by introducing new conditions, has destroyed the confidence long placed in water-bound roads. With fair use and careful maintenance the roadway possessed a tonnage life of 100,000 tons per yard of width. With the severer use of mechanically-propelled vehicles such a length of life cannot be guaranteed, and some of the superficial measures adopted with the view of giving increased stability have not proved a success. The addition of bituminous material on the surface, for example, a concession to motor cars and increased rapidity of locomotion, has occasionally shortened the life of the original road, or made repairs more expensive. In the case of horse-drawn vehicles the destructive effect could be traced to the blows of the horses' feet displacing the individual stones of the mosaic surface. With motor cars, the destructive agent is a shearing force developed between the wheel and the road, a force that increases with speed and weight. In New York State the number of motor trucks has increased enormously of late years, carrying weights up to 15 tons at a speed of about 15 miles an hour. Such a class of traffic calls for a stronger foundation support and greater care in providing a surface that will stand the grinding action of the wheels. To meet the requirements of the future science will have to solve many new problems that will tax the skill and enterprise of the best-trained engineers.

Professor Blanchard keeps steadily in view the demand of the immediate future, employing the fullest experience of the past as a guide to the new construction. Dust prevention, noiselessness and low traction resistance are desiderata for the moment, and since an asphaltic "carpet" contributes to these qualities, much consideration is given to bituminous materials, whether in use as palliatives or incorporated into the road by mechanical mixing. In passing, we may note that the author does not regard the pathological effects of dust as a serious menace to public health. Even in crowded and notably filthy towns he considers the risk of infection from inhalation of dust as very slight. The injurious effect of dust on the pulmonary organs is mechanical, the consequent irritation rendering them more susceptible to the attacks of the tubercle bacilli. The evils of dust or its annoyance are sufficiently pronounced to have led to many remedial proposals, both temporary and permanent. Watering has long been our only palliative, but in America, where light oils and tars are abundant, these have been used with some success as temporary palliatives. One sprinkling applied with a pressure distributor is stated to be effective for at least six weeks, but too frequent applications are liable to give rise to a soft, greasy surface. One gallon is sufficient for about six square yards, and care has to be exercised lest disintegration of the surface follows. On this ground the suggestion that has found some support in this country, that such treatment would enable water-bound broken stone roads to resist the effects of high-speed motor traffic, is untenable. To secure a permanent, impervious, dust-resisting pavement, recourse must be had to a properly constructed bituminous surface. Sheet asphalt, in which the uppermost or wearing course is composed of asphaltic cement and sand of suitable grading, incorporated by mixing, has much to recommend it. Bituminous concrete pavements, or those of cement concrete to which a bituminous surface of tar or tar asphalt has been applied give very satisfactory results.

Noise is reduced to a minimum on wooden block pavements, though bituminous surfaces are held in high estimation. Unfortunately wooden blocks are apt to be slippery in wet weather, though the same objection can be urged against asphalt. Now that the treatment of wood by preservative methods is conducted on scientific lines, this form of pavement is coming much into favour, a soft wood such as pine being preferred to the hard Australian type originally employed.

The tractive force required to draw vehicles over a given road depends on so many variables that it is difficult to establish any definite conclusion.

The effect of the material forming the surface is not easily separable from that depending on its condition: the description of vehicle, the magnitude and distribution of load, the variation of gradient and several other factors vary very considerably and lead to discordant results. The following table, drawn up by Professor McCormick, expresses the generally received opinion of the relationship existing between different wearing surfaces and the tractive force in pounds per ton:—

Surface Character.	Tractive Force per Ton. lb.
Earth packed and dry	100
Earth—muddy	190
Sand—loose	320
Gravel—good	51
Gravel—loose	147
Macadam—average	46
Sheet asphalt	38
Asphaltic concrete	40
Vitrified brick—new	56
Wood block—good	33

We have mentioned only three of the more conspicuous features to be taken into account in deciding the choice of road material and construction. Had other factors been allowed to enter, and especially the controlling ones of cost, the complicated character of the problem would have been more evident, and confirmed our contention that no pavement can be recommended as most suitable under all circumstances. In the subjoined table has been drawn up a scale indicating within certain limits the relative merits of various materials used in road construction. Such a table assists decision when, from local conditions, particular attention has to be directed to securing special ends.

	First Cost.	Ease of Traction.	Non-slipperiness.	Ease of cleaning.	Noiselessness.	Freedom from Dust.
Ideal pavement	10	10	10	10	10	10
Sheet asphalt	3	10	4	10	7	10
Brick on concrete	5	8	8	9	6	9
Stone block on concrete	1	3	7	7	3	8
Wood block on coucrete	1	9	4	9	9	7
Cement concrete...	6	9	6	8	6	7
Bituminous concrete	7	9	7	9	9	9
Bituminous macadam	7	8	7	9	9	8
Bituminous surface on broken stone	8	8	7	9	9	8
Broken stone with dust palliative ...	9	6	8	3	10	6
Broken stone	9	6	10	3	10	4
Gravel	9	5	10	1	10	3
Earth	10	2	10	1	10	1

The sum of the items would have little or no meaning, but we may note that for general all-round excellence a bituminous concrete stands very high. A truer use of the table is to show that whatever be the care or expenditure expended on certain, classes of roads, such as gravel or earth, certain particular qualities cannot reach a high standard.

Professor Blanchard's book is well illustrated and indexed. His description of road building, of the precautions to be observed, of the labour-saving appliances that can be invoked, of the advantages and limitations of testing materials and of all the details of construction is as full as space permits. His style is encouraging and helpful to students, who will find in these pages an able introduction to a subject that is seen to be deserving of systematic and acute observation.

The Data of Geochemistry. Third Edition. By FRANK WIGGLESWORTH CLARKE. United States Geological Survey. Bulletin 616. Washington: Government Printing Office.

IT is difficult to say what a book like "The Data of Geochemistry," an octavo volume of 821 pages, should contain. The reader who, in glancing through the book, happens to notice in the first instance the ten pages giving brief characteristics of all the chemical elements might fancy—especially if the name of the author should not convey anything to him—that it is a compilation of the general-information type, which has hardly an equivalent in this country, but is much appreciated in young countries. A closer perusal will at once make the reader regret the absence of an English equivalent. Though primarily compiled possibly in order to enable the intelligent geologist, engineer or farmer, who finds himself more or less limited to his own resources in some out of the way place, to study Nature and to utilise the natural resources of the district, the volume is really a compendium of geological chemistry in its widest sense with special regard to genetic features, written in plain but strictly scientific language and copiously stocked with literature references.

The author, whose status is not explained in the book, is Mr. F. W. Clarke, Professor of Mineralogical Chemistry at the University of Washington and Chief Chemist to the Geological Survey of the United States; he is further well known as the senior member of the International Commission on atomic weights, which every year issues a table of Atomic Weights. In its main divisions the volume deals with the elements, the atmosphere, lakes and rivers, the ocean, waters of closed basins, mineral wells and springs, saline residues, volcanic gases and sublimates, the molten magmas, rock-forming minerals, igneous rocks, their decomposition, sedimentary and detrital rocks, metamorphic rocks, metallic ores, natural hydrocarbons, and coal. The first edition of this work appeared in 1908, the second dates from 1911. In this third edition there might possibly have been left out some references to older views in some cases and more prominence given to most recent researches, *e.g.*, on the constitution of coal. But there is very little indeed that could be spared. We were glad, for instance, to find analyses of the carnotites of Colorado, minerals of rather variable composition and one of the chief sources of radium. A recent Bulletin of the Bureau of Mines had rather annoyed us by giving full particulars of the treatment of carnotites for radium extraction without containing a single analysis of the carnotite used. The reader of the "Geochemistry" may also be surprised—although the fact was noticed by Priestley—to see that granites, basalts and most other rocks evolve gases when heated like quartz and many metals. These gases may be occluded or may be due to reactions between the constituents of the mineral itself or between the mineral and other substances, notably water; the gases certainly play a very important part in volcanic phenomena. The volume teems with useful data and can strongly be recommended.

BOOKS RECEIVED.

United States Geological Survey. Bulletins: No. 606. *Origin of the Zinc and Lead Deposits of the Joplin Region, Missouri, Kansas and Oklahoma.* By C. E. SIEBENTHAL. No. 616. *The Data of Geochemistry.* Third Edition. By FRANK WIGGLESWORTH CLARKE. Washington: Government Printing Office.

United States Geological Survey. Contributions to Economic Geology. Bulletins: No. 620—I. *A Reconnaissance of the Cottonwood-American Fork Mining Region, Utah.* By B. S. BUTLER and G. S. LOUGHLIN. With *Notes on History and Production.* By V. C. HEIKES. No. 620—K. *Recent Alunite Developments near Marysvale and Beaver, Utah.* By G. F. LOUGHLIN. No. 620—L. *Notes on the Fine Gold of Snake River, Idaho.* By J. M. HILL. No. 620—P. *Preliminary Report on the Economic Geology of Gilpin County, Colorado.* By EDSON S. BASTIN and JAMES M. HILL. No. 620—N. *The Aztec Gold Mine, Baldy, New Mexico.* By WILLIS T. LEE. No. 620.—R. *Cassiterite in San Diego County, California.* By WALDEMAR T. SCHALLER. No. 621—K. *Geology and Coal Resources of Northern Teton County, Montana.* By EUGENE STEBINGER. No. 621—L. *Oil and Gas Near Basin, Big Horn County, Wyoming.* By CHARLES T. LUPTON. No. 621—N. *Structure of the Berea Oil Sand in the Summerfield Quadrangle Guernsey, Noble and Monroe Counties, Ohio.* By D. DALE CONDIT. No. 621—O. *Structure of the Berea Oil Sand in the Woodsfield Quadrangle, Belmont, Monroe, Noble and Guernsey Counties, Ohio.* By D. DALE CONDIT. Washington: Government Printing Office.

Heat and Temperature in Their Relation to Work. By JOHN ROGER. New York: The Publisher's Printing Company.

Hydraulics. By R. L. DAUGHERTY, A.B., M.E. London: McGraw-Hill Publishing Company, Limited. [Price 10*s.* 6*d.* net.]

Gas Engine Ignition. Prepared in the extension division of the University of Wisconsin by EARLE B. NORRIS, M.E., ROBERT T. WINNING, B.S., and WILLIAM C. WEAVER, B.S. London: Hill Publishing Company, Limited. [Price 6*s.* 3*d.* net.]

Mechanical Engineers' Handbook. Based on the *Hütte* and prepared by a staff of specialists. LIONEL S. MARKS, Editor-in-Chief. London: Hill Publishing Company, Limited. [Price 21*s.* net.]

The Panama Canal: an Emergency Treatise. A Series of Papers Covering in Full Detail the Technical Problems involved in the Construction of the Panama Canal. Prepared by Engineers and other Specialists under the direction of GEORGE W. GOETHALS, Major-General, United States Army. Two volumes. London: Hill Publishing Company, Limited. [*Price* 31*s.* 6*d.* net.]

FOREIGN ENGINEERING PROJECTS.

WE give below a few data on several foreign engineering projects, taken from the *Board of Trade Journal*. Further information on these projects can be obtained from the Commercial Intelligence Branch, Board of Trade, 73, Basinghall-street, London, E.C.

China.—H.M. Consul-General at Yunnan-fu reports that the representative in Yunnan-fu of a British firm established in Hong Kong desires to receive catalogues and price lists from United Kingdom manufacturers of the following articles, for all of which he has inquiries:—Complete plant for making cement, bricks, paper and matches (safety and phosphorus), all of the smallest commercial size; complete plant and machinery for weaving; complete installation for tannery; complete plant and machinery for boot and harness making; cotton-mill machinery; printing and lithographing machinery; type makers and general printing supplies; complete plant of the smallest commercial size for soap factory; antimony smelting plant capable of an output of 10 to 50 tons per month; water turbines of small power for high and low falls; suspension bridges (50 ft. to 300 ft. span) for light traffic; fire appliances, comprising portable steam and chemical engines and pumps, also extinguishers; tobacco cutting machines (finest cut leaf to be sent with catalogue); steam motor wagons and trailer wagons; road-making machinery; hand ploughs; high-speed steam generating sets, direct-coupled three-phase alternators of 2,200 volts, 50 to 500 h.p.; boilers for foregoing steam sets; portable railway rolling-stock; colliery tipping tubs; narrow-gauge locomotives, 20 tons; mono-rail trucks; diaphragm pumps of largest capacity; rice machines for hand power; sugar crushers for hand, horse and other power; oil mill plant; general mining and ore-washing plant; aerial railway equipment for transportation of coal; telephone exchanges for 50 to 500 subscribers; blasting powders; and also military brass band instruments. Prices for all goods should be quoted in sterling, f.o.b. United Kingdom Ports, and the weights of the heaviest pieces and gross weights should be given. All the goods must be capable of being easily transported and special attention should be paid to the heaviest pieces, which should be reduced in weight as far as possible. Communications in this connection should be addressed, and catalogues and price lists forwarded, to the British Consulate-General, Yunnan-fu.

Spain.—The *Gaceta de Madrid* publishes a Law authorising the Minister of Fomento to accept an advance of 2,550,000 pesetas (about 108,000*l.* at current rate of exchange) offered by the Provincial Authorities of Guipúzcoa and Alava for the completion of the section of the Estella Railway from Vittoria to its junction with the Durango-Zumárraga line. The undertaking is to be put in hand at once, and the Minister is empowered to arrange for calls for tenders for the carrying out of the necessary works, and the acquisition of fixed or rolling-stock required for the working of the line. The loan will be repaid by the Government, without interest, within four years from January 1, 1917.

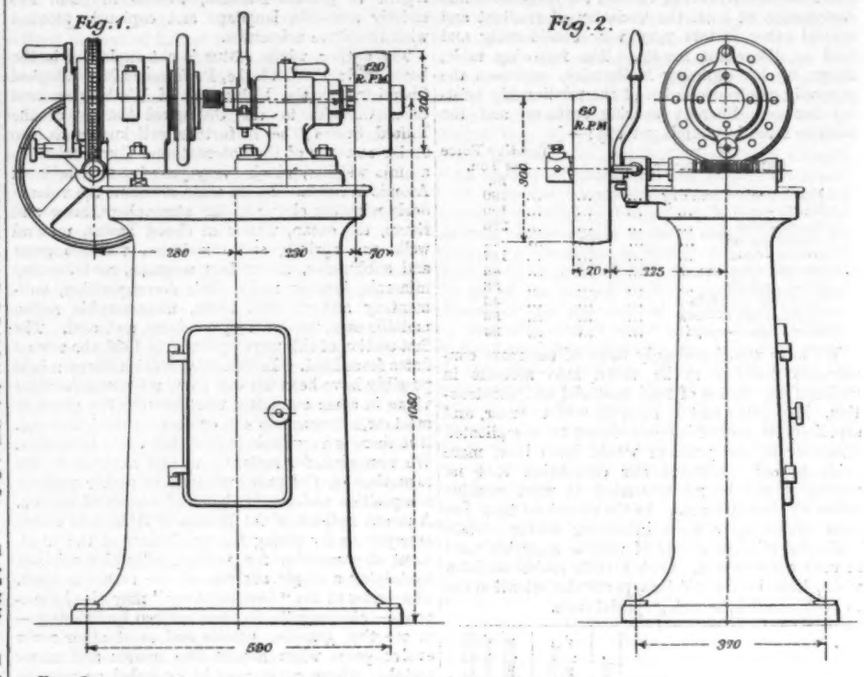
Chile.—In a report to his Government, published in Commerce Reports (Washington), of July 14, the United States Consul at Antofagasta writes that there is very little irrigation by pumping in the Antofagasta district. The wells in the pampa contain so much salt and other alkalis that they are not suitable for irrigation purposes. The market for pumps in this district is almost exclusively confined to the requirements of the nitrate plants. In this, the arid region of Chile, there are some 170 plants for the working up of nitrate of soda and each has a pumping installation complete. A nitrate plant uses from 300 to 900 tons of water per day, obtained usually from wells several miles away from the plant. The classes of pumps and pumping machinery used by the nitrate plants are as follows:—Power-driven deep well pumps usually single acting, triplex, of bucket type (the depth of well varies from 60 to 500 ft.); surface force pumps power-driven, for delivery of water from well to nitrate plants (power is usually furnished from central electric power station at plant some miles distant); boiler feed pumps, almost exclusively steam-driven, as are also the oil pumps for supplying fuel to the furnaces; steam or other power-driven pumps for transferring liquors from crystallisation tanks to elevated storage tanks; from 2 to 10 centrifugal pumps, usually 6 in. suction and 6 in. discharge for circulating hot liquors between the boiling tanks (the average centrifugal pump deals with from 200 to 400 gallons per minute against a head of 30 ft.); and miscellaneous internal combustion engine cooling water pumps, fuel oil pumps, &c. The general terms of credit given by American manufacturers to importers are cash against shipping documents on arrival of goods in Antofagasta. European manufacturers give extended credit of 60 to 90 days after acceptance of draft against bill of lading on arrival of goods, and in exceptional cases 120 days. Prices should be c.i.f. Antofagasta, and not f.o.b.

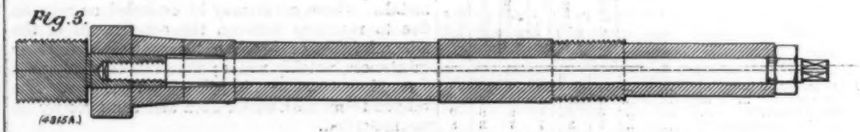
AMERICAN LOCOMOTIVE BUILDING.—Orders for 74 locomotives were given out in the first three weeks of July. The American Locomotive Company is to build 10 consolidated locomotives for the Duluth, Winnipeg and Pacific Railroad, 19 for the Central Railway of Brazil, and 13 for miscellaneous foreign railways. The Philadelphia and Reading Railroad Company proposes to build 10 switching engines in its own shops. The Cincinnatti, New Orleans, and Texas Railroad Company has ordered five shunting-type locomotives from the Baldwin Locomotive Works and four switching engines from the Lima Locomotive Corporation.

THE "A. L." SCREW-THREAD MILLING MACHINE.

We have received from the Imperial Motor Industry, Limited, 11, Denmark-street, Charing Cross-road, W.C., particulars of the machine which we illustrate in Figs. 1 to 4 herewith. It has been specially designed for cutting the threads in shells and has been extensively used in France, whilst it has recently been introduced into Italy for a similar purpose. The cutter holder is shown in Fig. 3; it is of strong and simple construction. The thread cutter is firmly fixed to the shaft of the holder by means of a cross pin, and the holder itself being held over its whole length inside the tailstock, all vibration is avoided, a most accurate working of the machine is obtained and there is no undue wear on the cutter. The machine is started running by throwing it into gear with the starting lever, when the cutter revolves at a speed of about 150 r.p.m., and is driven in to the exact depth to be threaded. The threads are cut once and for one revolution of the shell, and whilst the shell completes this revolution, the chuck which holds it advances inside the headstock against the cutter, by the action of a lead screw. The shell is made fast in the chuck by means of a hand-wheel which acts upon a vice; no spanner or other special tool is required for this, thereby avoiding any loss of time. One man can attend to two machines; the threading of one shell takes about 3 minutes and the power required for the machine designed for 3-in. shells, the one we illustrate, is about ¼ h.p. The dimensions in Figs. 1 and 2 are metrical. The machine is built in Switzerland.

THE "A. L." SCREW-THREAD MILLING MACHINE.





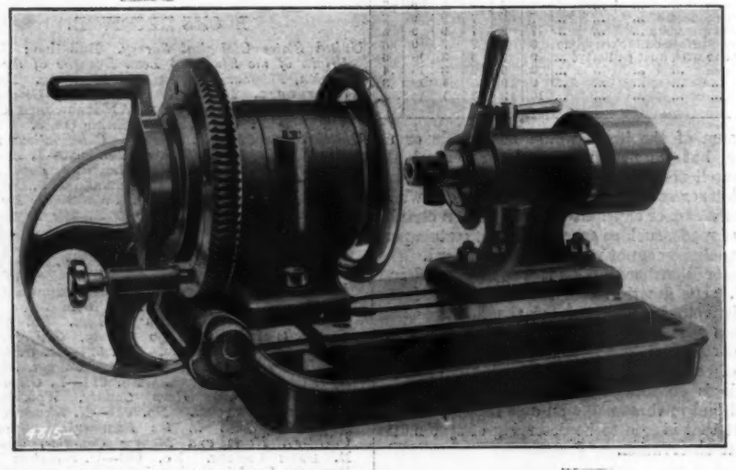


Fig. 4.

Rubber.—The imports of rubber into the United Kingdom have not been well maintained this year, having only amounted to July 31 to 98,280,700 lb., as compared with 111,922,200 lb. in the corresponding period of 1915, and 90,756,400 lb. in the corresponding period of 1914.

Our Rails Abroad.—Our rail exports in July showed a severe decrease, being valued at only 35,230*l.*, as compared with 258,642*l.* in July, 1915, and 288,586*l.* in July, 1914. Shipments to the Argentine Republic almost ceased in July, and India only took rails to the value of 12,821*l.* during the month, as compared with 66,266*l.* in July, 1915, and 99,048*l.* in July, 1914. The aggregate shipments to July 31 this year represented a value of 311,430*l.*, as compared with 1,113,673*l.* and 3,050,315*l.* in the corresponding periods of 1915 and 1914.

Our Locomotive Exports.—Our locomotive exports continue to decline, but in July they showed more strength, the value of the shipments for the month having been 140,902*l.*, as compared with 59,209*l.* in June. The aggregate exports to July 31 this year were valued at 727,500*l.*, as compared with 1,490,895*l.* and 2,431,324*l.* in the corresponding periods of 1915 and 1914 respectively. There has been more doing of late with the Argentine Republic, and this has helped up this year's business a little. The value of the deliveries to Argentina in July was 158,098*l.*, as compared with 69,985*l.* and 587,673*l.*

Manchester Ship Canal.—The death was announced on Saturday of Mr. J. K. Bythell, who was Chairman of the Manchester Ship Canal Company for 20 years, and who rescued it from a struggling obscurity. The Canal having become a dividend-earning undertaking, Mr. Bythell retired from the chairmanship in February this year, and the shareholders increased his proposed retiring allowance from 500*l.* to 1,000*l.* per annum. Mr. Bythell retired from a firm of East Indian shippers in 1884 in order to devote his whole time and energy to the development of the Canal, and his efforts were rewarded with a large measure of success.

To New Zealand *via* Panama.—On July 15 the steamship Remuera, of the New Zealand Shipping Company, on its way from Wellington to London, passed through the Panama Canal. The former route was 4,461 miles from Wellington to Cape Horn, 1,355 to Monte Video, and 6,200 to England, or 12,016 miles in all. The new route is approximately 11,188 miles. Outward from Great Britain, around the Cape of Good Hope, the distance from Plymouth to Wellington is 12,916 miles by way of Tenerife, Cape Town, Hobart and Auckland. The saving by the Canal over this is 1,500 miles, or five days' steaming. The Canal authorities provide bunker coal at cheap prices in spite of the war.

Our Coal Abroad.—Our exports of coal appear to be languishing, the shipments for July having been 3,404,117 tons, as compared with 3,539,117 tons in July, 1915, and 6,599,487 tons in July, 1914. These totals were increased by the addition of coke and patent fuel to 3,574,137 tons, 3,731,932 tons and 6,917,843 tons. In the seven months ended July 31 this year our coal shipments were 22,379,578 tons, against 25,871,707 tons, and 41,186,419 tons in 1915 and 1914 (corresponding periods), these totals being increased to 24,078,824 tons, 27,109,106 tons and 43,066,760 tons by the addition of coke and patent fuel. Bunker coal was shipped for the use of steamers engaged in foreign trade in the first seven months of this year to the extent of 7,589,900 tons, as compared with 8,499,198 tons and 12,101,590 tons.

Artists' Rifles Journal.—We have received the first copy of the Artists' Rifles Journal, the object of which is to explain the formation of the Artists' Rifles Regimental Association. The journal gives the reasons for the formation of this Association and the objects of the latter. Some details are included of the work of the regiment since mobilisation. There is little doubt that a journal of this sort, when properly kept up, constitutes a record of the doings of a regiment which prove of great value and interest. The London address of the Association is 17, Craven-street, Strand.

Iron and Steel Institute.—The Autumn Meeting of the Institute will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Thursday and Friday, September 21 and 22, 1916, commencing at 10.30 a.m. on the 21st and at 10 a.m. on the 22nd. The following is the list of papers that are expected to be submitted for reading and discussion:—(1) H. Brearley, "Some Properties of Ingots." (2) Professor E. D. Campbell, "Influence of Heat-Treatment on the Thermo-Electric Properties and Specific Resistance of Carbon Steels." (3) Dr. H. M. Howe and A. G. Levy, "Heat Treatment of Eutectoid Carbon Steels." (4) J. N. Kilby, "Steel Ingot Defects." (5) Herbert K. Scott, "Manganese Ores of Bukowina, Austria." (6) Dr. J. E. Stead, F.R.S., "Influence of Elements on the Properties of Steel." (7) Dr. J. E. Stead, F.R.S., "Notes on (*a*) Nickel Steel Scale; (*b*) The Reduction of Solid Nickel and Copper Oxides by Solid Iron. (*c*) Effect of Blast Furnace Gases on Wrought Iron." (8) G. F. Zimmer, "Use of Meteoric Iron by Primitive Man."

The China Year-Book.—This year-book has now been issued. It is edited by Mr. H. T. Montague Bell, B.A., and Mr. H. G. W. Woodhead, M.J.I., and is published at the price of 10*s.* net by Messrs. George Routledge and Sons, Limited, London. It gives very interesting information on the population, coastal configuration, hydrography, geology, products, manufactures, commerce, railways, army, navy, finance, &c., of China, all of which will be found useful by British trading firms engaged in business with the country. The book also contains many chapters of great interest to the general public, such, for example, as those dealing with education, public justice, constitutional development, religions, &c., of the vast Chinese territory. The book covers over 700 pages, and has a very complete index.

CAPACITY AND ECONOMY OF MULTIPLE EVAPORATORS.*

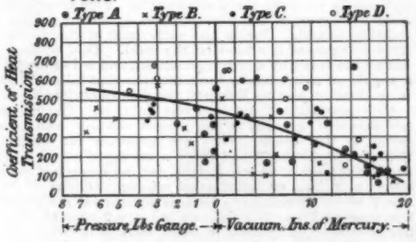
By E. W. KERR, Baton Rouge, La.

(*Concluded from page* 167.)

The coefficients for all tests are plotted against pressure of steam in Fig. 9. The variation is shown to be very wide, the principal value of this plot being to fix limits. Similarly Fig. 10 gives the results of the laboratory tests given in the former paper. It will be noted that the coefficients for the laboratory tests are higher than those from the full-size factory evaporators. This is doubtless due to the fact that the heating surface in the laboratory apparatus was always clean, and that there was a better distribution of steam with the smaller calandria. Some of the tests were made with the apparatus operating under conditions so poor that to consider the data from them in comparing types would be unfair. In nearly all cases the tests were made without special preparation, the time since cleaning, &c., varying considerably. It is interesting to note that the coefficients obtained are higher than with ordinary surface condensers and equally as high as with modern types of high vacuum surface condensers.

Table II. gives the coefficients for each body for quadruples of the different types. Table III. gives the average, maximum and minimum coefficients for each type taken from the same tests. It will be noted that the highest actual coefficients were obtained from type F (atmospheric double effect). These high coefficients were doubtless due to the high steam pressure and the corresponding high density of the steam. As apparent temperature fall was used in determining the coefficients, they not only indicate the relative heat transmitting ability of the heating surface in the different types, but include also the effect of peculiarities due to type, such as hydrostatic head, method of removing condensation, method of venting, &c. It will be noted that the film evaporators (types C and D) gave coefficients considerably higher than did the submerged tube types.

Fig. 9. COEFFICIENTS OF HEAT TRANSMISSION, ALL TESTS ON SUGAR HOUSE EVAPORATORS.



Comparing types A and B it will be noted that the latter has some advantage, the average actual coefficient for type B being some 8 per cent. greater than the average for type A. The tests of type E show an average coefficient of 248, which is some 25 per cent. greater than the average for type A. Comparing types C and D, the average coefficient for the former is 392, which is some 47 per cent. greater than that of the latter. Type C requires centrifugal circulating pumps for handling the juice, something not required by other types. Tests of motors driving these pumps showed 0.1 h.p. per 1,000 gallons of juice treated per 24 hours. This should be kept in mind in comparing this type with others. Only one test was made upon type G, and this under conditions which could hardly be called favourable, the amount of juice supplied being far below its rated capacity and the juice head greater than would have been used had it been operated with an amount of juice nearer its normal capacity.

TABLE II.—*Coefficient of Heat Transmission.*
(Actual.)

Type.	1st Body.	2nd Body.	3rd Body.	4th Body.
A	410	340	265	145
B	400	330	240	135
C	680	650	525	220
D	430	395	320	180
F	685	400	—	—
G	682	571	365	138

With type A only four evaporators out of a total of 11 gave coefficients above 200. In these four the conditions of operation were fair as regards cleanliness, drainage and venting. The number of days since cleaning is given in the paper for each test, though this can hardly be relied upon to give an accurate idea of the condition of the heating surface, for the reason that all of the evaporators had not been cleaned with equal thoroughness. In practice the time consumed in boiling out, also the strength of the soda and acid, vary greatly. In some cases the thoroughness of cleaning is not sufficient to prevent a progressive fouling of the heating surface toward the end of the season.

It will be noted that practically all of the tests on type A were made with very low steam pressure in the first body, usually near atmospheric pressure, and in some cases less than atmospheric pressure. With most of the other types the pressure was higher, which puts type A at a disadvantage in making comparisons with the average coefficients given. According to laboratory tests, the coefficient of heat transmission varies according to the expression U = 225 + 17,500 D, where D = density of heating steam in pounds per cubic foot. This formula was used in calculating the corrected coefficients given in the last column of Table III. These corrected coefficients may perhaps give a better means of comparing types than the actual coefficients, especially as regards types A and B. However, too much dependence should not be placed on these corrected coefficients, as the correction formula was determined from laboratory experiments.

Considering the four tests giving the highest coefficients for types A and B, the rating is :—

(Actual)	
Type A	100
Type B	106
(Corrected for difference in initial steam pressures)	
Type A	100
Type B	96

The fairest comparison of types C and D will be obtained by using only tests 23 to 25 and 27 to 29, which were made on evaporators at the same factory and where the operating conditions were equally favourable.

(Actual)	
Type C	117
Type D	100

The evaporators of type B were of two classes, namely, *a* with small tubes ($\frac{3}{4}$ in. and $\frac{7}{8}$ in.) and *b* with larger tubes ($1\frac{1}{2}$ in.). Tests 15 and 16 with small tubes, and tests 20 and 21 with large tubes, were made under conditions that should afford a fair comparison. The ratings are :—

(Actual)	
Small tubes	100
Large tubes	142
(Corrected for difference in initial steam pressures)	
Small tubes	100
Large tubes	111

Rate of Evaporation per Square Foot of Heating Surface per Hour.—So far all comparisons have been made in terms of the coefficient of heat transmission. The unit "pounds of water evaporated per square foot of heating surface per hour" is convenient for rating evaporators, and is fairly satisfactory provided the steam pressure and the vacuum do not vary greatly. Table IV. gives averages of water evaporated per square foot of heating surface per hour for each type tested. The actual values do not furnish a fair comparison on account of the widely varying steam pressure and vacuum. An attempt has been made to determine the equivalent evaporation that would have resulted had all tests been made with a steam pressure of 5 lb. gauge in the first body and a vacuum of 26 in. in the last body. This equivalent is termed corrected water evaporated per square foot of heating surface per hour. The method of calculating the corrected value is as follows :—

Fig. 10. COEFFICIENTS OF HEAT TRANSMISSION. LABORATORY TESTS.

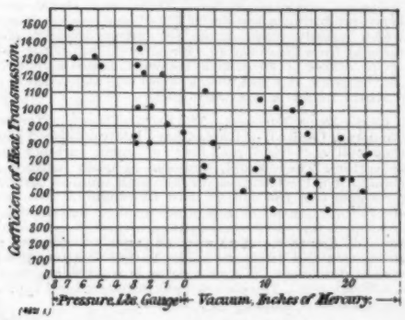


TABLE III.—*Coefficient of Heat Transmission.*
(Actual.)

Type.	Average.	Maximum.	Minimum.	No. of Tests included in Average.	Relative Coefficient (Actual) Standard = 100.	Relative Coefficient (Corrected) Standard = 100.
A	197	289	172	7	100	100
B	213	291	130	5	108	74
C	392	449	334	3	199	160
D	266	353	190	6	135	119
E	248	284	190	3	126	180
F	503	509	498	2	255	131
G	293	—	—	1	149	139

TABLE IV.—*Water Evaporated per Square Foot of Heating Surface per Hour.*
(From Tests Plotted in Figures in the Paper.)

Type.		Actual Equiv. to 75 per Cent. Evap.			Corrected 5-lb. Gauge and 26-in. Vac.		
		Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average
A.	Quadruple ..	—	—	5.55	—	—	6.18
A.	Triple ..	8.31	5.07	6.56	10.8	8.15	9.2
A.	Double ..	11.64	7.20	9.42	19.4	13.6	16.7
B.	Quadruple ..	7.89	4.82	5.89	5.61	3.87	4.55
B.	Triple ..	11.18	11.18	11.18	12.61	10.68	11.49
C.	Quadruple ..	9.20	7.90	8.75	11.42	9.56	11.05
D.	Quadruple ..	8.75	7.75	8.21	10.87	9.45	10.05
D.	Triple ..	7.38	6.62	7.11	9.6	7.45	9.21
E.	Triple ..	6.33	4.85	5.46	10.63	27.65	16.93
F.	Double ..	6.74	5.43	6.085	17.8	17.0	17.4
G.	Quadruple ..	—	—	6.092	—	—	9.67

For example, in test 27 the total temperature fall for the conditions of the test was 87 deg. and for the corrected conditions 102.5 deg. were assumed. The actual average coefficient for the conditions of the test was 325, and for the corrected conditions 343. The corrected rate sought is

$$\frac{8.75 \times 102.5 \times 343}{87 \times 325} = 10.7$$

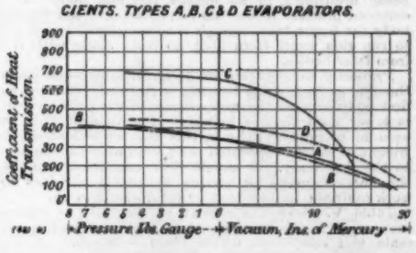
It is not claimed that these corrected values can be absolutely accurate, but rather an approximation to the results that would be obtained with the conditions assumed.

Thermal Efficiency.—In thirteen of the evaporator tests recorded in Table I. (page 166 *ante*) the condensed steam from the first body was weighed. Partial data regarding steam consumed for these tests are given in the same table. Table V. (page 190) gives more complete data relating to steam consumption in these tests.

The factors which affect the weight of steam required to evaporate a given weight of water are : number of bodies ; radiation losses ; losses due to vents ; method of handling condensation ; temperature of juice entering.

One pound of steam entering the first body of a multiple evaporator causes the evaporation of approximately 1 lb. of water in each body, that is, 1 lb. of steam evaporates approximately 2 lb. of water in a double effect ; 3 lb. in a triple effect ; and 4 lb. in a quadruple effect. This reaction does not hold exactly, for reasons which will be discussed later.

Fig. 11. COMPARISON OF HEAT TRANSMISSION COEFFICIENTS. TYPES A, B, C & D EVAPORATORS.



The loss due to radiation varies directly as the difference between the temperature inside the evaporator and the atmosphere outside. This temperature difference is of course greater with atmospheric evaporators than with vacuum evaporators. It is also greater in the first body of a vacuum evaporator than in succeeding bodies. The radiation loss also varies directly as the ratio of radiating surface to water evaporated. This ratio will be less with large evaporators than with small ones, and is affected by type also. Reference to Table V. will show something regarding the value of this ratio for the evaporators tested. Naturally the radiation loss is affected by the kind and amount of insulating covering used. The loss due to radiation in the first bodies of an evaporator is multiplied ; for example, the loss from the first body of a quadruple is multiplied by 4 ; that from the second body is multiplied by 3, &c. In view of this, it is evident that the total radiation loss from a quadruple will be greater than that from a triple, &c., other conditions being the same. A theoretical calculation will show that this loss should be relatively small. A rough calculation based on an average coefficient of radiation of about 2.8 British thermal units per square foot of radiating surface per hour per degree Fahrenheit difference shows the following losses in percentage of the heat delivered in the steam to the first body :—

—	Uncovered.	Fully Covered.	Three-fourths Covered.
Double	1.06	0.26	0.46
Triple	4.2	1.05	2.07
Quadruple	9.8	2.7	5.0

These figures are for a 10-ft. standard effect, including the vapour pipes, with steam at 5 lb. gauge and a vacuum of 27 in.

Primarily, vent pipes are for the purpose of removing incondensable gases only. If this were carried out the vent losses would be small, in fact they are probably small in general practice, even though some steam is vented with the gases. This loss, like the radiation loss, is multiplied for all bodies except the last. The vents may be connected to the next body or to the condenser direct. The former is probably more economical, though the latter is better as far as heat transmission is

* Paper read before the American Society of Mechanical Engineers.

TABLE V.—Data from Tests Relative to Economy.

(See footnotes, Table I, page 166 *ante*.)

Test No.	Type.	No. of Bodies.	Rated Capacity, gal. per 24 hr.	Actual Capacity, per cent. of Rated	Radiating Surface per 100,000 gal. per 24 hr., Actually Evaporated, sq. ft.	Portion of Radiating Surface Covered, per cent. of Total.	Steam Temperature 1st Body, Deg. Fahr.	Method of Venting.	Method of Removing Condensation.	Steam* Supplied to 1st Body for Heating per cent. of Total.	Water Evaporated per lb. of Steam, lb.	Thermal Efficiency, per cent.
7	A	2	125,000	145	—	—	212.5	*ad*	*e*	− 6.13	2.09	94.5
14	B	4	145,000	109	1,921	73.50	234.9	*d*	Note 2	8.9	3.52	85.1
15	B	4	145,000	174	1,207	73.50	232.8	*d*	Note 2	5.89	3.7	89.1
17	B	4	250,000	86	1,780	0	224.5	*c*	*e*	11.73	3.4	90.5
23	C	4	400,000	94	832	100	225.4	Spec.	*g*	8.06	3.71	96.9
24	C	4	400,000	94	832	100	221.5	Spec.	*g*	7.83	3.95	97.5
25	C	4	400,000	76	1,026	100	222.0	Spec.	*g*	9.67	3.69	97.5
27	D	4	400,000	138	694	95	222.0	Note 3	*f*	1.19	4.21	97.2
28	D	4	400,000	124	774	95	222.1	Note 3	*f*	− 0.50	4.24	94.8
29	D	4	400,000	131	734	95	222.8	Note 3	*f*	− 2.37	4.28	93.3
30	D	3	200,000	93	946	0	212.4	None	*f*	−12.98	2.91	86.5
31	D	3	200,000	95	923	0	208.3	None	*f*	− 9.85	3.09	90.6
33	E	3	220,000	105	990	40	211.9	Fig. 6	*f*	7.46	2.49	97.4

* Minus values are for initial juice temperatures higher than the boiling temperature.

concerned. This loss is apt to be greatest in the early bodies, especially if the vent openings are too large. In order to reduce losses due to venting, it is important to design evaporators so that effective separation of gases from steam may be brought about. Attention has already been called to the fact that this has been attempted in types C, E, F and G.

Of the three general methods of handling the condensed steam from evaporators, *b* (see footnote, Table I.) evidently should be most economical for the reason that all of the condensation leaves the last body at the lowest possible temperature, the saving due to this arrangement being multiplied in all except the last body. It is common practice to use the condensation from the first body for boiler feed, though theoretically it would pay to run this water from body to body along with that from later bodies.

Primarily, evaporators are designed to vaporise water, though, in fact, some heating is generally done in the first body because the temperature of the juice entering is lower than that of boiling. It is evident that the amount of heating done in this manner will affect the weight of water evaporated per pound of steam supplied to the first body. It should be remembered also that the steam supplied for heating in this manner does not work multiple, as does that used for evaporation.

Table V. gives the results of the tests as regards economy. It also includes information regarding the main test conditions which affect economy. A unit commonly used for measuring economy is "pounds of water evaporated per pound of steam supplied to the first body." This unit does not furnish a fair means of comparing the economy of different evaporators, however, for the reason that it does not account for variation in conditions. Thermal efficiency is more accurate, and the method of calculating this item has already been given. It will be noted that it varies from a minimum of 85.06 to 98.3, the average being 94 per cent. The table shows that the efficiency of type C was higher than type D, although the water evaporated per pound of steam supplied was greater in the latter than in the former. This apparent contradiction is due to two things: (1) the temperature of the juice entering the first body in the tests on type D was higher than in those on type C, more steam being required for heating in type C; (2) the condensation in type D was taken from body to body, beginning with the second, whereas it was drained away separately from each body of type C. The low efficiencies obtained in the tests on type B quadruple, tests 14 and 15, are probably due to the small size, whereas both the C and D quadruples were of large size. Attention is called to the data in Table V. regarding the ratio of radiating surface to water evaporated in the different types.

Type 17 on a type B quadruple evaporator gave an efficiency of 90.48 per cent. This is relatively low for an evaporator of this size and is doubtless due to the fact that it was not insulated. The low efficiencies obtained in tests 30 and 31 on a type D triple are doubtless due also to the fact that it was not insulated. These tests were made soon after the apparatus had been installed and before the covering had been applied. An inspection of this table will show the effect of high rates of evaporation in increasing heat efficiency; in fact some of the irregularity in the results can only be explained in this way.

CATALOGUES.

Pneumatic Stone Dressers.—In a bulletin recently issued by the Chicago Pneumatic Tool Company, of Fisher-building, Chicago, we have brief descriptions of a number of tools specially arranged to make them convenient for stone working. There are two types of hammer, one with a valve and the other valveless. They are made in four sizes, ranging from $\frac{7}{8}$ in. diameter up to $1\frac{1}{4}$ in. diameter. Surfacing tools, compressors and rock drills are also illustrated.

Machine Tools.—At the present time, when there is such an abnormal demand for machine tools, works managers will be relieved to see a little list recently issued by Messrs. H. W. Ward and Co., Limited, of Lionel-street, Birmingham. The machine tools of this firm need no description in Engineering, but it is noteworthy that they have a wide variety, both new and second-hand, of lathes, millers, shapers, drilling machines, &c., which they can deliver from September onwards.

Chemical Fire-Extinguishers.—From the Valor Company, Limited, of Rocky-lane, Aston Cross, Birmingham, we have received price lists of their "New Era" and "Fyrout" fire extinguishers. These are of the chemical type, producing a stream of liquid and carbon-dioxide which quickly smothers a fire, and are made in sizes ranging from those suitable for carrying on motor cabs up to others of 30 gallons capacity, large enough for the brigades of small towns where the expenditure on a steam pump is not warranted.

Curtis Steam Turbines.—The British Thomson-Houston Company, Limited, of Rugby, have lately published what they call a "descriptive list" of steam turbines and generators. They would, however, be quite justified in naming it a brief treatise on the Curtis impulse turbine, for it goes into the subject most thoroughly. Not only are the mechanical details of the machine described and illustrated, but the thermo-dynamical problems involved are also discussed. A number of pages are devoted to alternators and reference made to gear-driven direct-current dynamos. The publication is excellently printed and illustrated. The photographs include several typical installations of units up to 7,500 kw.

Roller Bearings.—Messrs. Broom and Wade, of High Wycombe, have published a new price-list of Hyatt roller bearings, in which the well-known advantages of substituting rolling contact for sliding are set forth. The outstanding feature of the Hyatt bearing is, of course, the method of forming the rollers from a helically coiled bar of steel. This gives the roller flexibility and permits the bearing being applied direct to any steel shaft of good quality and condition. The list covers bearings of from $1\frac{1}{4}$ in. up to 5 in. diameter fitted into plummer blocks, brackets and hangers. There are also some illustrations of Hyatt bearings for trucks and colliery tubs, but these are dealt with at greater length in other publications of the same firm.

Dynamos and Motors.—A new pamphlet (No. 21c), dealing with continuous current dynamos and motors, has recently been issued by Messrs. Bruce Peebles and Co., Limited, of Edinburgh. The machines are of medium size, that is to say, up to about 80 kwts. or 100 h.p., and are of five distinct types, viz., protected, semi-enclosed, totally enclosed, mining type, and pipe ventilated. With the exception of the smaller sizes, below $3\frac{1}{2}$ h.p., these motors have four main poles, and are also fitted with commutating poles. The small units have two poles. Standard voltages are 115, 230 and 460, but the machines can be run on circuits varying from the standards by a considerable amount without seriously affecting their outputs.

Helical Gearing.—The Fawcus Machine Company, of Pittsburgh, Pa., U.S.A., have sent us a catalogue of herringbone gears for transmitting power. The uses to which reduction gearing is put are so diverse that the catalogue is naturally of a general nature, but it includes a list of standardised gears having ratios of from 3–1 up to 12–1. In the case of fine pitches the wheels are produced from plain blanks by means of a hobbing process; but for coarse pitches, such as those of rolling mill pinions, the teeth are planed out. The two halves of each tooth are cut at the same time. Thus, by means of a special system of templates, great accuracy in spacing and form is ensured. Clearance for the cutting tools at the apices of the teeth is provided by a turned groove or slight recesses cast in the blank.

Blue Printing Appliances.—A pamphlet describing their photo-copying machines has been sent to us by the Westinghouse Cooper Hewitt Company, Limited, of 80, York-road, King's Cross, London, N. The machine naturally utilises the Cooper Hewitt mercury vapour lamp as its source of light, and the economy of this, as compared with the arc lamp, is such that, with electricity at 1*d.* per unit, the operating costs are only $\frac{1}{2}$*d.* an hour. Accuracy of product will, however, appeal more strongly to most engineers, and in this respect the machine is most satisfactory. The glass cylinder within which the lamps are situated rotates together with the tracing and printing paper. Creeping of one on the other is thus prevented and distortion of the drawing avoided. The same company also manufacture a machine for automatically washing, drying and ironing blue prints.

Pyrometers.—A new list of radiation and optical pyrometers has been issued by the Cambridge Scientific Instrument Company, Limited, of Cambridge, who manufacture under the Féry patents. The Féry pyrometers are of two types, thermo-electric and mechanical. In the first the radiation from the body under observation is focused on a thermo-pile, and the electro-motive force thus generated is measured by a galvanometer. The galvanometer can be of the indicating type, giving only a reading of the temporary temperature, or it can be arranged to make a continuous record. In the mechanical pyrometer the heat radiation is focused on a small spiral made of two dissimilar metals, which consequently uncoils and gives a direct indication of the temperature. The range of these instruments is up to 1700 deg. C. Another very simple form of pyrometer depends upon the matching of the light from the hot body with that coming from a standard incandescent electric lamp. The two beams are both rendered monochromatic, and thus the instrument can be used by colour-blind observers. It is, in fact, eminently suited for use in the workshop, on account of its portability. The scales are graduated up to as high as 4000 deg. C. (above the temperature of the electric arc), and it is possible to secure an everyday accuracy in readings of 10 deg. above or below the correct temperature.

Cast-Steel Railway Wheels.—The American Steel Foundries, of Chicago and New York, have sent us a striking booklet dealing with the Davis steel wheel for railway rolling stock. The Davis wheel is the successor to the chilled iron wheel, and has been brought into existence by the steadily increasing loads adopted on American railroads. Previous to its inception many attempts had been made to produce a wheel having the simplicity of the solid iron casting combined with the strength of the built steel wheel; but no method was then available for hardening the treads sufficiently to make them serviceable. This trouble has been overcome in the Davis wheel by casting it in a rotating mould. During the early part of the pouring ferro-manganese is added to the steel. This is carried out to the tread by centrifugal action, and is followed by a supply of soft steel to form the disc and hub. There is no distinct parting between the two qualities of steel—they gradually blend into one another. The wheels are annealed, ground to the correct contour, and tempered on the treads. They are naturally far stronger than cast-iron wheels and effect a saving of about $\frac{1}{4}$ ton deadweight on a 50-ton freight car, as compared with either cast iron or rolled steel wheels. Of the 83,000 Davis wheels which have been in service for more than two years and four months, only 185, or 0.2 per cent., have been removed on account of wear, damage or defects.

Air Compressors and Portable Tools.—The Consolidated Pneumatic Tool Company, Limited, of Palace Chambers, 9, Bridge Street, Westminster, S.W., have sent us a number of circulars relating to their products. One of these circulars gives particulars of small power-driven air compressors of the vertical enclosed type, suitable for air pressures of 100 lb. per sq. in. They are made in three sizes, two of which have single cylinders capable of handling 8 cub. ft. and 21 cub. ft. of free air per minute respectively, and one has duplex cylinders with a capacity of 42 cub. ft. per minute. Larger air compressors of the horizontal, single-cylinder, enclosed type, arranged for driving either by belts, steam cylinders, or electric motors, are dealt with in another circular. These compressors are fitted with "Simplate" flat-disc inlet and discharge valves, which are specially designed for high-speed working, and are claimed to be practically indestructible. Steam and belt-driven compressors are listed with capacities of from 51 to 1120 cub. ft. of free air per minute. Other circulars deal, respectively, with "Duntley" heavy-duty portable electric drills and grinding-machines, and "Hummer" pneumatic self-rotating hammer drills. An interesting feature of the "Hummer" drills is that the rotation of the drilling bit is effected by a small air motor, of the rotary type, through which the air passes before it reaches the hammer cylinder. These drills are made in three sizes, for holes up to 6 ft., 8 ft., and 12 ft. deep respectively. Full particulars are given of each size, and lists of spare parts are also included in the circular.

The Serbian Mines.—We read in *La Lumière Electrique* that the German-Bulgarian Union, of Dresden, has published the results of Bulgarian mineral researches carried out in the eastern part of Old Serbia. According to these researches there are extensive coal basins between the Mava and the Peck, to the south-east of Pororeva. The Dobra mine has a capacity of about 25,000 tons per year. On the Miroteh mountain, to the south of Tetkia there is a coal bed 30 km. (18.7 miles) in length. At Zaistchar, a colliery which has been working for the last 25 years and is connected by rail with Radujevac, on the Danube, supplies from 30,000 to 40,000 tons per year. The Malakaon Reka bed is given a length of 3 km. (1.8 miles) and an estimated capacity of 5 million tons. Sonich, located at a distance of 22 km. (13.7 miles) from the Belgrade-Sofia railway line, can yield a large coal output. The coal basin at Alexinats is given a length of 6 km. (3.7 miles). Coal is also found at Rtani, near Kniajevats, and in the Morava Valley, at Tzidilis. The copper mines are the Bor, the Kuka Dulkan and the Maidan Pek mines; copper is also found at Studina, to the south of Nisch. The iron-bearing districts are in the Kapacnik range.

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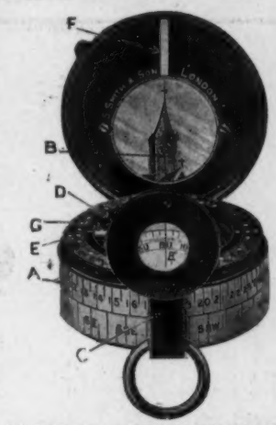

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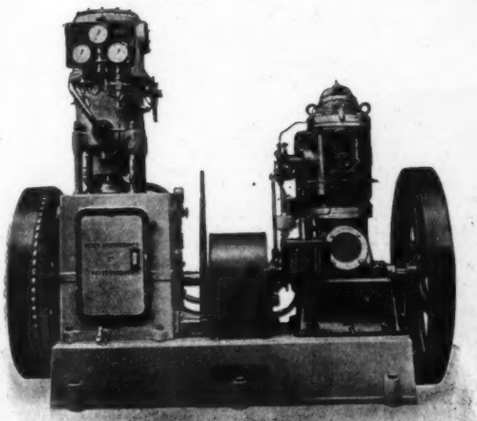

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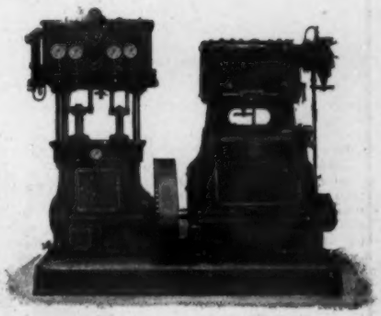

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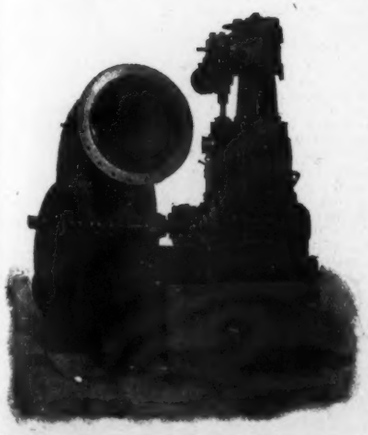

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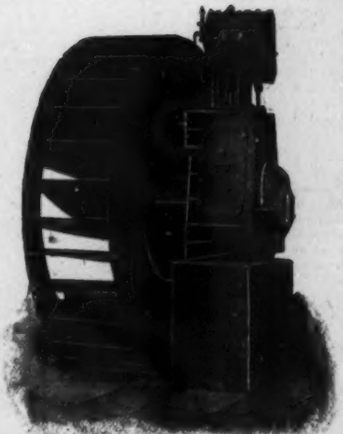

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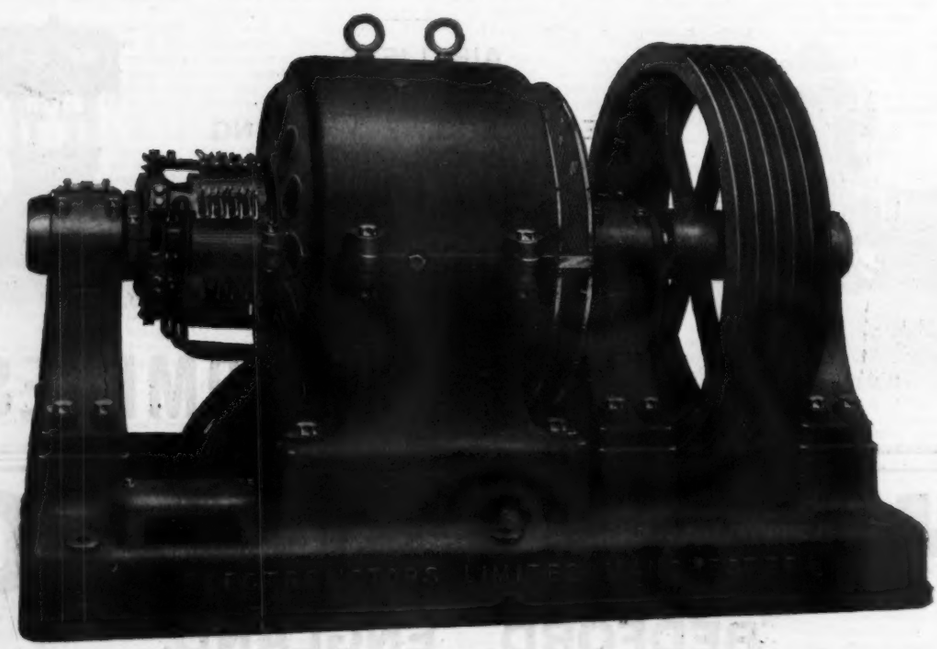

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